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PRODUCTION

NOVEMBER 1985

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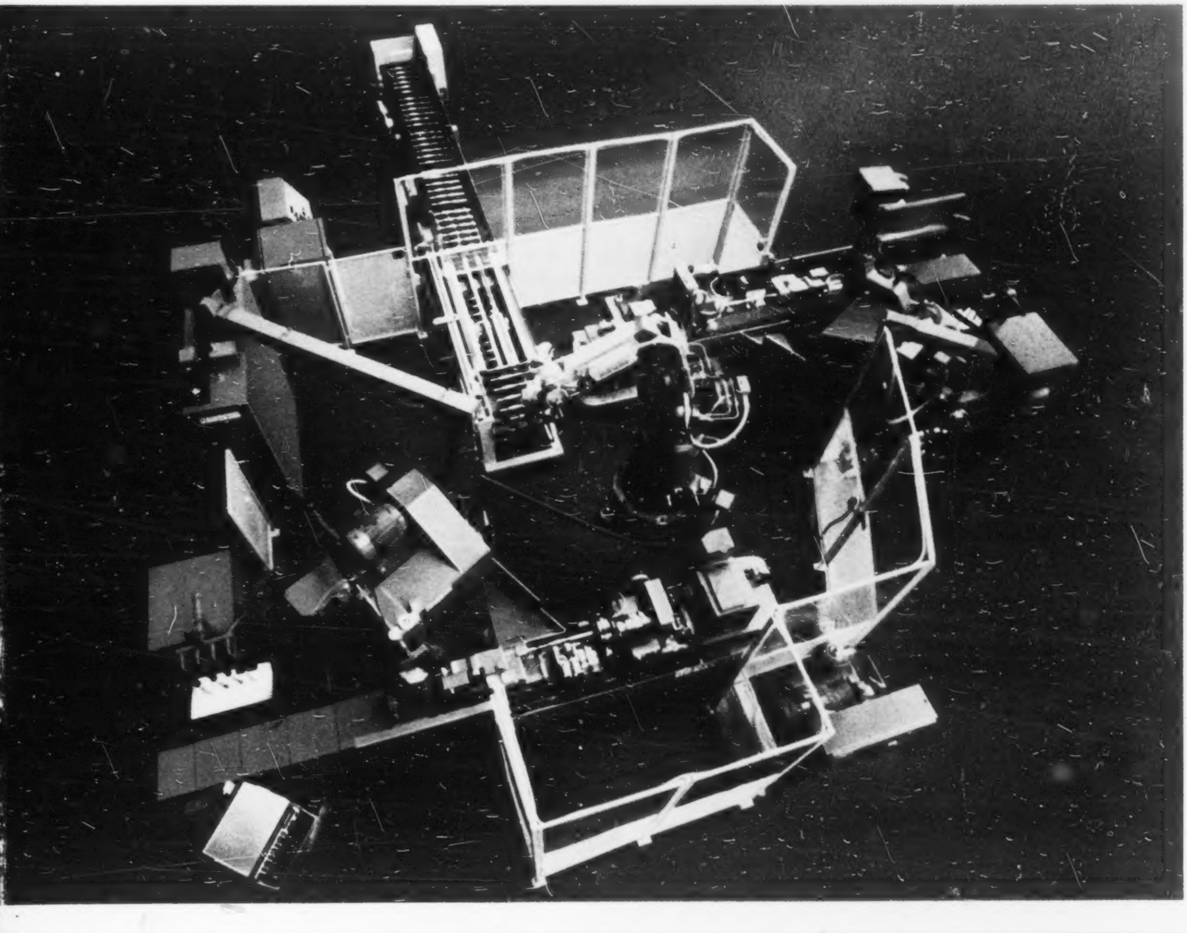

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November 1985

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'Expert Systems' Capture Manufacturing Brainpower

Built-in knowledge handles novel problems and accepts uncertainty in response to requests for information

Michael J. Wilson
Associate Editor

Intelligence. Reasoning. Heuristic judgment. These are some of the terms being applied to artificial intelligence, the subfield of computer science concerned with symbolic reasoning and problem solving.

Artificial intelligence (AI) has been around for 30 years, but the majority of activity has been in university research laboratories addressing theoretical problems. However, recent advancements have made it possible for computer systems to achieve, in many cases, levels of problem solving equal to or better than the best human performance in various disciplines. Recent developments have made it practical to apply artificial intelligence techniques to solve critical problems in the manufacturing industry. Manufacturers are turning to AI vendors to improve their operations.

AI's potential is summed up by Richard E. Morley, director of advanced technology, Gould, Inc., Amherst, NH: "Artificial intelligence represents the edge of the intellectual revolution, which should change our lives at least as much as the industrial revolution. The industrial revolution substituted machines for muscles; artificial intelligence substitutes minds for machines."

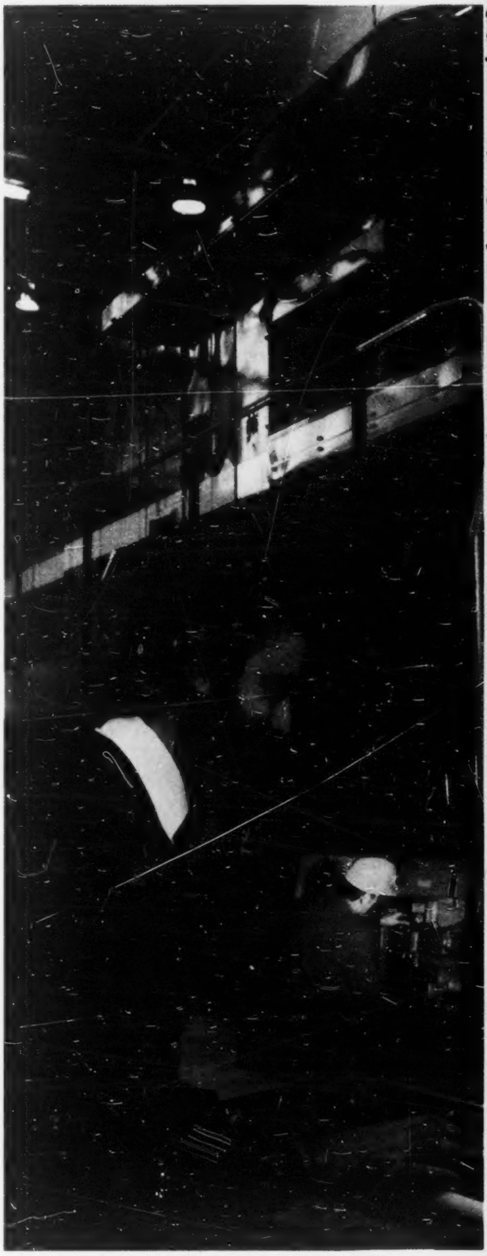
AI as a commercial venture also is in its infancy. The market in 1984 for all AI-based products was $125 million, according to Aim Publications, Inc., Natick, MA, publishers of *Artificial Intelligence Markets* newsletter. Aim projects the market to more than double, to $265 million this year, reach $895 million in 1987 and jump to $4.4 billion in 1990. In 1984 software accounted for 36 percent of revenues and that is expected to grow to 43 percent by 1990.

The impact of AI on the industrial marketplace involves knowledge-based expert systems, robotics, machine vision, speech and natural language processing.

AI appears to be where robotics was five to seven years ago—a high growth area with a bright future supported by venture capital.

Expert Systems

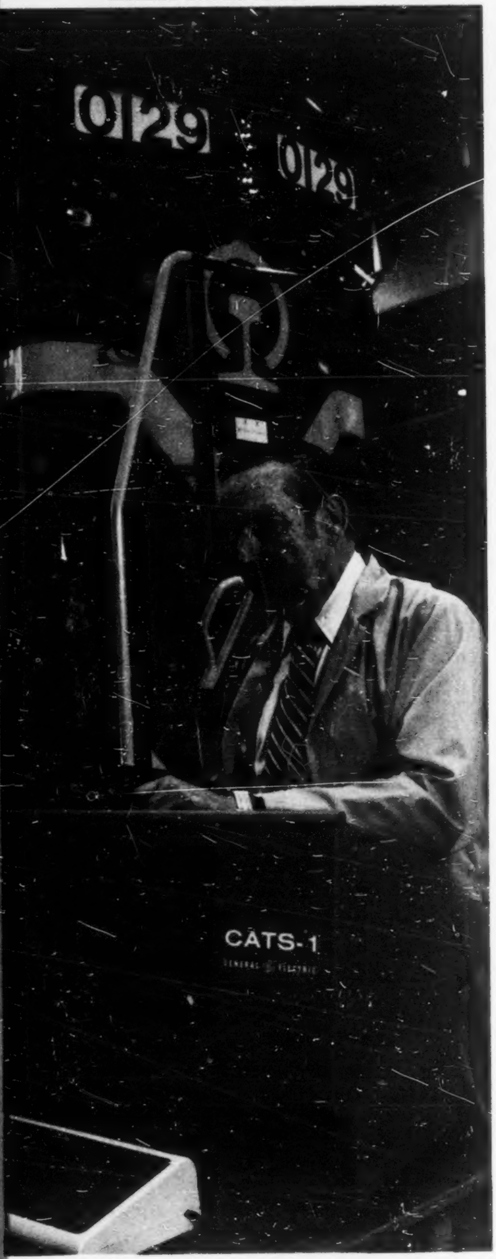
Knowledge-based expert systems are the area where AI made the most progress in the last few years. In the manufacturing industry this includes software programs that emulate the decision-making process of human experts. Expert systems have been successfully applied to equipment diagnosis, inventory control, order entry, planning, design, etc. Expert systems are being developed today that debug automatic assembly lines, troubleshoot electronic circuit problems, schedule job shops and monitor and coordinate FMS systems on a real-time basis. In the future they will advise manage-



ment on strategic planning.

Expert systems concentrate the collective processing power of public and private knowledge on specialized areas, or domains, according to Richard A. Herrod, Ph.D, senior technical staff, Texas Instruments, Inc., Dallas. "This provides expert levels of performance where human experts are either unavailable or not cost effective. Expert systems smooth the transition and serve as a training tool for new personnel when expert personnel retire, transfer or quit."

GE researchers troubleshoot locomotives via the CATS expert system. It displays detailed drawings of various locomotive components during a question/answer troubleshooting procedure. Repair procedures are demonstrated on a video monitor shown at left



Instead of being programmed to follow step-by-step procedures, an expert system is programmed to follow a few general procedures for finding solutions to problems, he explains. "Rules of thumb, models, facts and other knowledge about solving a problem are stored in computer memory. To solve a particular problem the computer utilizes facts provided by the user plus its domain knowledge and general problem solving procedures to find a solution.

"Knowledge used by expert systems is usually encoded in the form of rules," he continues. "Rules contain an antecedent and a consequent. An antecedent typically contains several clauses linked by ANDs and ORs. The consequent contains one or more action phrases that specify what is to be done when the rule 'fires.' A typical rule for an automobile diagnosis might be: IF having trouble starting engine, AND starter can crank engine, AND engine is receiving gasoline, THEN check for ignition problem."

To build an expert system a skilled knowledge engineer interviews domain experts and compiles information from documents, books and manuals to establish a knowledge base. This information is coded into the computer, often in LISP language. A prototype system is built, tested, modified and debugged until it attains expert performance. It is an incremental process. A simple prototype can be built in one year, a medium difficult project takes three to five years and difficult systems take seven to ten. Even then modifications are still made. An expert system is never complete; it can always be improved.

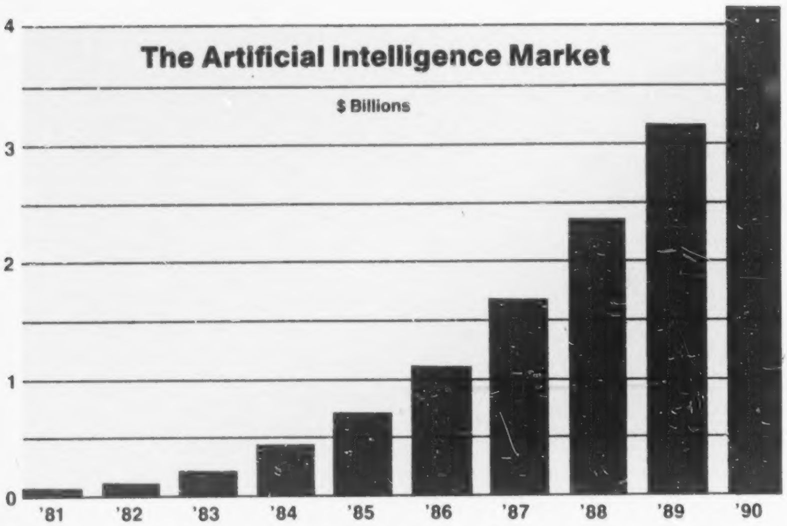
Interest in AI is worldwide. Companies in and the governments of Japan, Britain, France and other European nations are competing with the U.S. for AI leadership. Japan's fifth generation computer project, the so-called "thinking computer," is intended to support inference engines for expert systems targeted to dominate AI and the information industries by the 1990s. Domestically, about 200 to 300 companies are developing AI products. Industrial giants that have created in-house research programs include Gould, IBM, Texas Instruments, Digital Equipment Corp., Litton Industries, Northrop Corp., General Motors Corp. and its subsidiary Hughes Aircraft Corp.

However, most companies view AI as extremely competitive—something they hold close to their vest like they were playing poker for their last nickel. They don't want to reveal what they are doing or how they are doing it for fear of giving away secrets. Following are a few companies involved in AI whose experience varies from prototypes to expert systems. They are among the 150 to 200 with working expert systems or 500 to 1000 prototypes operating in the U.S.

Digital Equipment Corp.

Digital Equipment Corp., Hudson, MA, is a pioneer in industrial AI. The company has 200 people supporting about 50 internal AI productivity projects in manufacturing, diagnostic and service related applications, engineering and finance.

XCON (Expert Configurer) is DEC's oldest AI project and illustrates a classic expert system. It examines all VAX and PDP-11 computer orders ensuring that they have correct and complete configurations. This is an extremely difficult task because a VAX computer configuration is drawn from an infinite variety of combinations of disk drives, power supplies, memory, I/O channels, CPUs, cables,



Source: DM Data Inc., Scottsdale, AZ

cabinets, consoles, etc. FORTRAN and BASIC programs written in the '70s failed to solve this configuration checking problem because they lacked flexibility to handle all combinations.

In 1979 an XCON prototype was developed in conjunction with Carnegie-Mellon University, Pittsburgh, and became operational in 1980 with 750 IF/THEN rules. Today it has 5000 and is still growing. XCON verifies a typical configuration in one to two minutes, performs six times as many functions as a skilled engineer and is 95 percent accurate. In contrast, an engineer takes one to two hours and is only 75 percent accurate.

"We view AI including XCON as an adjunct, a positive addition to our set of software tools," says Arnold Kraft, artificial intelligence marketing specialist. "It is used daily and trusted. The system has paid for itself many times over."

General Electric Co.

General Electric Co., Transportation Systems Business Operation in Erie, PA, a manufacturer of diesel electric locomotives, entered into a joint development program in 1980 with the company's Corporate Research and Development Center in Schenectady, NY. Its objective was to build a stand-alone box to aid locomotive troubleshooting. The system, known as CATS—Computer Aided Troubleshooting—also is used to train employees.

A field test unit is installed at Burlington Northern Railroad and Union Pacific for hands-on use. "It is intended primarily for a new railroad employee, a transferee or a third shift operator without access to a troubleshooting expert," says Robert Herman, manager of technology support. "The concept is to take accumulated knowledge from a locomotive troubleshooting expert and bundle it in a box utilizing the latest computer technology. Conceivably you can build hundreds of these boxes and stretch the knowledge base to troubleshooters on the railroad shop floor."

The system utilizes a DEC (Maynard, MA) PDP 1173 programmed in FORTH, a Winchester disk, a terminal, a printer and a Sony laser disk player with monitor. It began with 400 rules and now has over 1000.

CATS aids troubleshooting like a decision tree by pursuing IF/THEN/ELSE rules, multiple choice or YES/NO questions. It might ask a multiple choice question such as, "DO YOU HAVE (A) A FUEL PROBLEM? (B) COMBUSTION PROBLEM? (C) LUBRICATION PROBLEM? (D) PROBLEM'S ORIGIN UNKNOWN." Selection of A, B, C or D prompts a different set of YES/NO questions: "IS THE ENGINE RUNNING AT FULL SPEED?" or "IS IT ACHIEVING FULL HORSEPOWER?" When the operator is unable to answer such questions, he presses a "help key" which displays on a CRT either a sound movie, a CAD drawing or a photograph, sometimes with audio, to illustrate and respond to the unanswered question.

"It is too new and small to say how many problems are being solved," cautions Herman. "It is not a panacea. This is a long term development progressing in a methodical fashion that we see more as evolutionary than revolutionary. What we learn from field testing will be incorporated into the next generation."

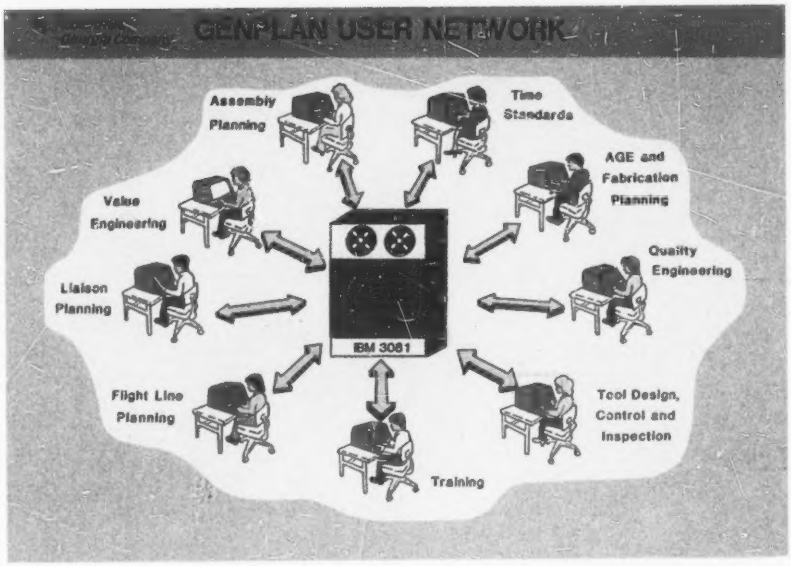
Westinghouse Electric Corp.

Westinghouse Electric Corp., Pittsburgh, recently demonstrated an expert system called ISIS—Intelligence Scheduling Information System—at the company's turbine plant in Winston-Salem, NC. The Carnegie-Mellon University-developed program combines AI with shop floor programming utilizing constraint directed reasoning. The system scheduled manufacturing of various length and shape turbines on about 25 machine tools for the demonstration.

"Scheduling is the premier problem in manufacturing," claims Peter Papas, manager-computer integration and software systems. "ISIS optimizes scheduling. It helps the changing manufacturing environment adjust to increased throughput, minimize work-in-process inventory, maximize machine utilization and react when materials don't arrive or operators aren't at their station."

The system also can be used in a simulation mode to determine if an incoming order is deliverable on time. After order entry the system might relate, for example, that to meet the delivery schedule, turning machine #3 requires a second shift for two days or perhaps the lack of semifinished material inventory will delay manufacturing operations.

The Westinghouse demonstration, performed under simulated conditions, was the first step in implementing this technology on the shop floor. The company is now executing the second phase of installing a LISP machine prototype consisting of about five machine tools at a smaller shop by year's end. Lessons learned from the prototype will be retrofitted to the turbine plant.



GenPlan user network interfaces with many planning and engineering phases of manufacturing (above). Joseph Tulkoff, director of manufacturing technology, Lockheed-Georgia Co., utilizes GenPlan to implement process plans for the C5B cargo airplane

Lockheed-Georgia Co.

Lockheed-Georgia Co., a division of Lockheed Corp., Marietta, GA, has developed a generative process planning system called GenPlan. The system creates in response to a group technology characterization code the initial plan for the manufacture of discrete aircraft parts, subassemblies and major assemblies.

It is a knowledge-based expert system established in 1978 that represents several thousand man-years of best factory practice and replaces a manual system. It allows a process engineer to create the documentation that identifies the optimum sequence of manufacturing operations. It details all necessary raw materials, tools, machines and processes and determines a time standard for each step.

GenPlan's knowledge base includes machining requirements, specifications, material requirements, etc. The system serves process planners, time standard engineers, quality control engineers and producibility engineers via 130 CRTs networked to an IBM 3083.

"The system provides many benefits," says Joseph Tulkoff, director of manufacturing technology. "For example, it saves 50 to 60 percent of process planning labor. Time standards are now consistent and accurate because humans have been eliminated from their calculations. Leadtime is reduced up to 75 percent. It eliminates key punching and verification. Furthermore, it has automatic control of configuration. That is, each process plan has a unique change code number which prevents two planners from changing the same plan."

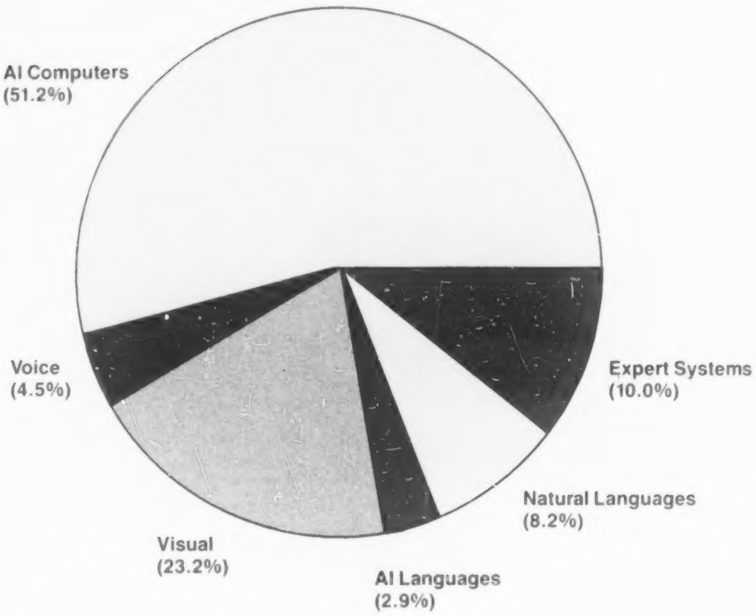
Benefits on the factory floor include uniform flow of parts. There are no missing or redundant operations and it saves material. For example, chucking a part on a lathe requires a specific length of stock for gripping by a collet or chuck. Human process planners vary considerably in this determination. But GenPlan always selects the right amount without variation.

Sandvik Coromant Co.

Sandvik Coromant Co., Fair Lawn, NJ, also has a process planning system and simulation program that includes some aspects of tool management. The system, known as SPOCK—Sandvik Productivity Optimization Cutting Knowledge — is an expert system based on 15 years of tooling and machine test data acquired worldwide. The system has been tested at General Motors Technical Center, Warren, MI, for the past year and is now being tested at manufacturing plants.

SPOCK is a software package written in BASIC A language that operates on an IBM XT or AT personal computer. It utilizes algorithms and a YES/NO menu format.

SPOCK's primary purpose is to optimize tooling data. The user selects the cutting tool insert grade and the program calculates speeds and feeds, tool life, cycle time—both machining and non-machining time—and provides a total time for one piece or a batch. In addition, it calculates the cost of



The Artificial Intelligence Market Product Areas — 1985

Source: DM Data Inc., Scottsdale, AZ

the entire operation. Total part cost is given if multiple machines are used. Costs are divided into labor, overhead, depreciation, tooling, etc. Times and costs of alternate machining methods are simulated on a bar graph providing a cost comparison.

An operator can input a specified surface finish requirement for a particular part and the program automatically calculates speeds and the best tool life under minimum cost conditions. Or, the operator picks the speed and the program predicts tool life. If a production increase is desired, the system reveals the required speeds and feeds.

"SPOCK will optimize constraints and cut cycle time by 30 percent," predicts Bertil Colding, vice president-advanced systems products. "It can reduce a process plan 80 percent and increase the output of process planners several times."

Gulf Oil Corp.

GREASE is an expert system that aids in the choice or formulation of a cutting fluid for a machining operation. It is currently under development at the Intelligent Systems Laboratory at Carnegie-Mellon University in cooperation with Gulf Oil Corp., a subsidiary of Chevron, San Francisco. The goal is to select a cutting fluid that will make a machining operation as economical as possible through trade-offs between the price of a cutting fluid and tool life.

Six Steps In Making an Expert System

(1) Pick a problem

(2) Extract knowledge from an expert

(3) Write rules in a program

(4) Test rules on small cases

(5) Go into live test

(6) Iterate into commercial use

** Courtesy Gould Inc., Amherst, NH*

GREASE performs a wide variety of tasks and handles various kinds of input. For instance, it will select the cutting fluid that will make machining operations most economical given a mix of metals being machined, a variety of machining operations, depths of cuts, speeds and other information. It also can diagnose difficulties with a cutting fluid currently in use. For example, it may reveal poor tool life caused by an excessive heat build-up during machining. A lower viscosity cutting fluid with better cooling properties may be prescribed. If no existing cutting fluid has the properties required for satisfactory performance, then GREASE creates a blend of cutting fluids that most closely matches the desired properties. In addition, it can explain and justify the selection of a special cutting fluid.

Although the potential for AI is immense, the technology is still developing. Expert system development is costly and companies involved in expert systems sometimes experience disillusionment after initial high expectations. A wide range of LISP dialects will not run on a machine that supports another dialect. Expert systems can be unpredictable or act ineptly at the border of their knowledge. The availability of skilled computer scientists experienced in expert systems is also holding back development processes.

While there are cautions, potential rewards are huge. As the technology matures reliability will improve and costs will fall. Its utilization on the factory floor will proliferate and increase factory effectiveness. It will preserve know-how and apply it in an optimum manner. It truly will be a versatile tool in the factory-of-the-future. ■

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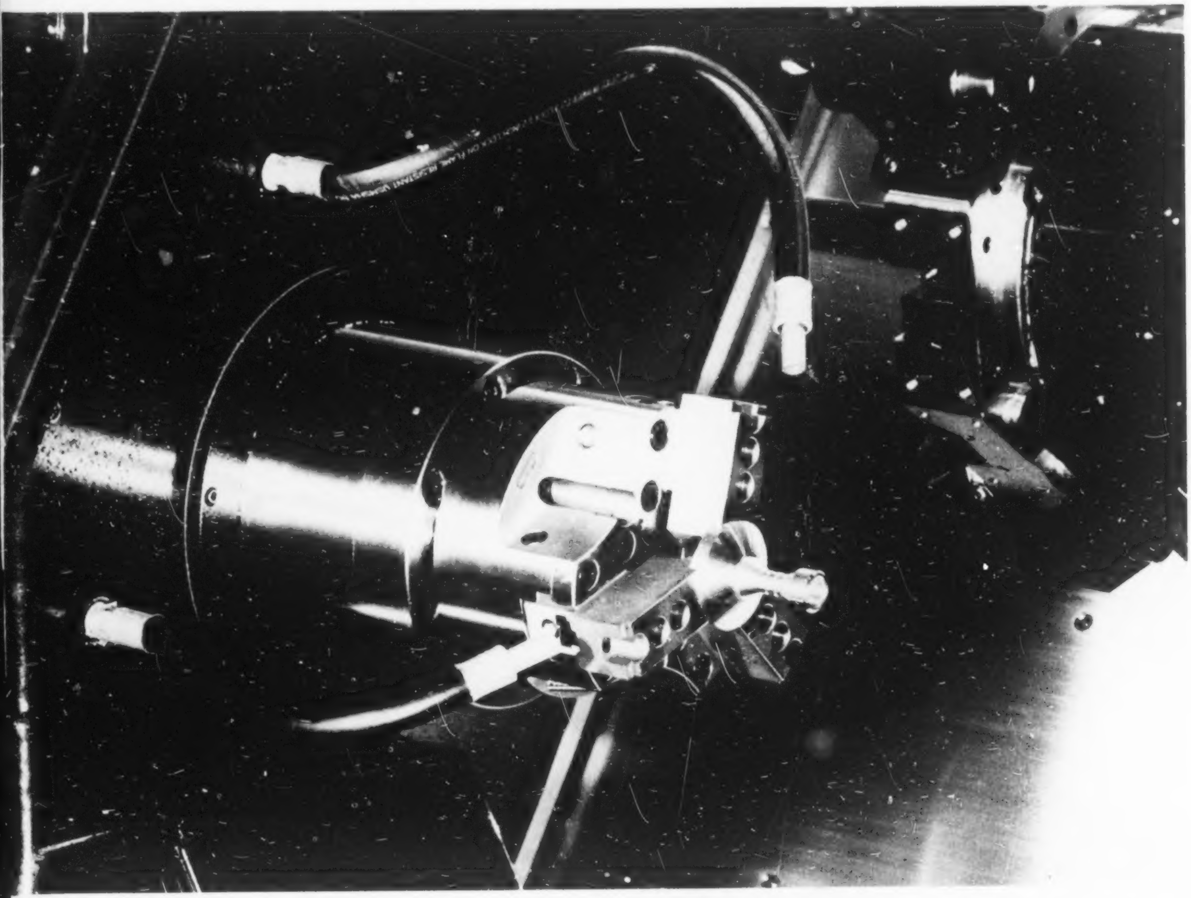

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Today's power-operated three-jaw chucks play an important role in holding workpieces in CNC lathes and turning centers.

NEXT MONTH:
A new look at a new Annual Issue.

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DiPietro Wins Robotics Award

Frank DiPietro, director of production engineering with General Motors Corp.'s C-P-C car group, has been selected as a 1985 Joseph F. Engelberger Award winner by the Robotics Industries Assn. (RIA) for his extensive application work with robotic technology.

As co-chairman of GM's Corporate Robotics and Machine Intelligence Council since 1980, DiPietro has been a driving force behind the explosive growth of robotics applications at GM. There were roughly 300 robots at work in GM facilities in 1980. Under DiPietro's encouragement, their application has dramatically increased to over 4000 installed robots today.

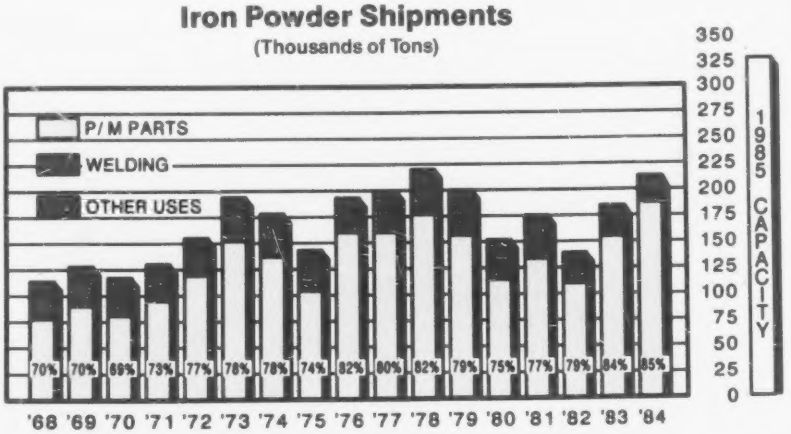
Japanese Robot Markets Expand

The *Japan Economic Journal* reports that Japan's manufacture of industrial robots rose sharply in 1984 due to Japanese industries' increased capital spending and rising exports.

A survey of 436 firms also revealed that assembly line robots have come into wide use in Japanese industries and the sale of high-tech robots with visual sensors increased substantially in 1984.

The sales of 48 robot makers totaled nearly $726 million last year, up almost 37 percent from the previous year. On the basis of continuing strong demand worldwide for industrial robots, the *Journal* estimates Japan's robot market will grow by more than 30 percent this year to about $1.2 billion.

INDUSTRY REPORT



Source: Metal Powder Industries Federation
Metal Powder Producers Association

More Powder Metallurgy

Precision metal parts for automobiles, computer equipment and other consumer and industrial products are being made more cost effective and reliable through increased use of powder metallurgy, according to Kempton H. Roll, executive director of the Metal Powder Industries Federation.

Roll reports that North American metal powder shipments increased 19 percent in 1984 to more than 300,000 tons. Registering gains were iron and steel, stainless steel, copper, aluminum, molybdenum, tungsten, tungsten carbide, nickel and tin powders.

The largest volume powders, iron and steel, reached 216,000 tons, a gain of almost 18 percent over 1983. Of this amount, powder metal parts shipments were 183,000 tons, a 19 percent increase.

The automotive industry will continue increasing its use of powder metal parts in engines, chassis, transmissions and accessories. Roll says one major American car maker is now committed to using powder metal forged connecting rods and also plans to dedicate a facility for the manufacture of P/M camshafts, both parts to appear in 1987 models.

GM-UAW Health Study

Using a $4 million fund set aside for occupational health research, General Motors Corp. and the United Auto Workers have contracted for a research team from Harvard University and the University of Massachusetts to conduct a four-year study to determine adverse health effects, if any, related to prolonged exposure to machining fluids.

Involving Saginaw Div. plants in Saginaw and Detroit and the Hydra-matic operations in Ypsilanti, MI, the study will be multifaceted. As many as 40,000 medical histories of individuals who have worked at these facilities

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JANUARY 1986

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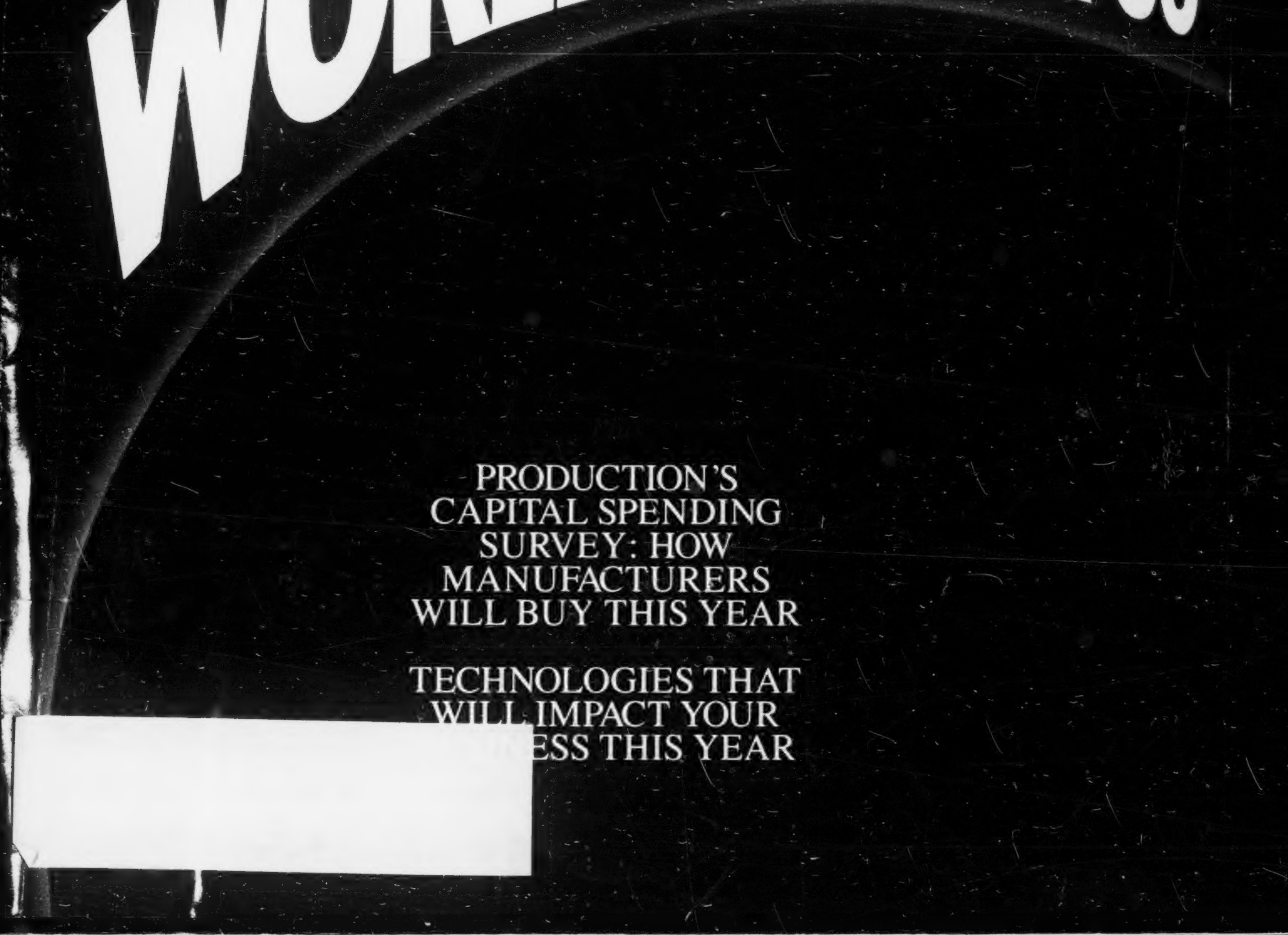
FOR MANAGERS OF MANUFACTURING TECHNOLOGY

Over 25 Exclusive Reports
On The Year Ahead
In Manufacturing

WORLD OUTLOOK '86



PRODUCTION'S
CAPITAL SPENDING
SURVEY: HOW
MANUFACTURERS
WILL BUY THIS YEAR

TECHNOLOGIES THAT
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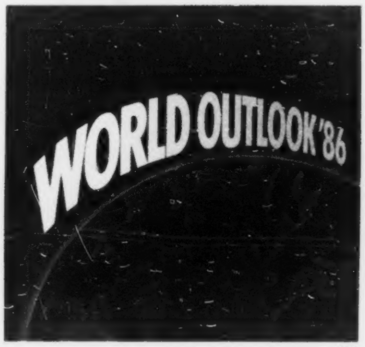

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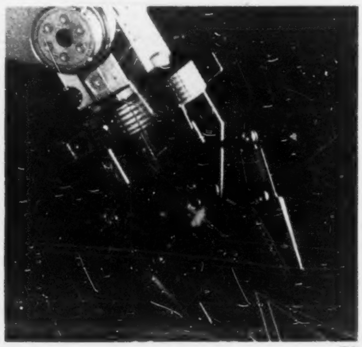

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to $4.0 billion this year after a 12 pct jump last year.

For the economy as a whole majority-owned affiliates plan to increase capital expenditures 2 pct this year to $40.9 billion after increasing their investment by 15 pct last year. However, said the Bureau, even if the increases planned for both years are realized, spending this year will be below the levels of 1980-82.

The 15 pct increase in spending expected last year probably reflects a decline in interest rates and the moderate economic recovery abroad, the BEA said. Based on previous experience, the 1985 spending estimate may be revised downward in later surveys, the government said.

The small increase planned for 1986 may partly reflect investors' uncertainty about the future pace of the business recovery abroad and the foreign currency value of the dollar, the Bureau said.

–Ed Bowers

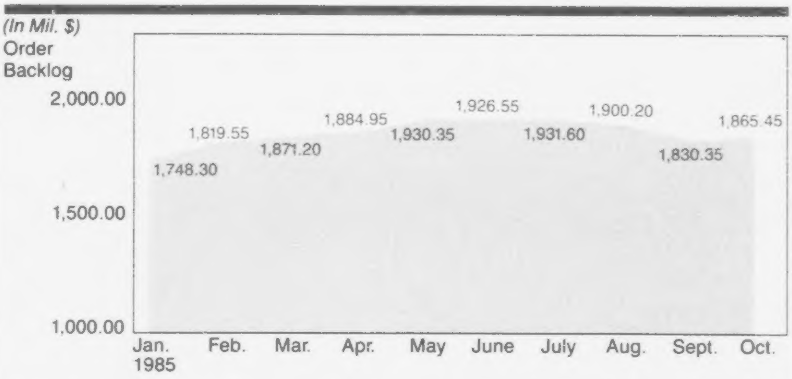
Machine Tool Orders Off 7 Pct

Reflecting fears by U.S. manufacturers that economic growth for the rest of this year and well into 1986 will be relatively weak, machine tool orders fell seven pct in September and are down 11 pct for the first three-quarters of this year, the National Machine Tool Builders' Association (NMTBA) said.

"We seem to be on another downslide after having struggled up to our previous recessionary lows," said NMTBA president James A. Gray. "Since June we have observed a steady decline in orders from $235 million to September's $172 million. We know the business investment dollars are there. We know that our products are competitive. And we know that American industry has the desire to buy capital equipment to modernize. What is missing is a vision of a growing future for manufacturing."

During September machine tool orders fell to $171.7 million compared with $184.5 million in August. Compared with September, 1984, orders in

MACHINE TOOL ORDERS
Backlog



WASHINGTON

New Orders At a Standstill NAPM Says

The U.S. economy maintained its steady pace in September according to the National Association of Purchasing Management.

In its latest report the group said production levels remained unchanged in October and new orders, the source of future production, eased only slightly. Vendor deliveries continued at just about the same pace. Employment picked up, but was still low and inventories declined as manufacturers began making seasonal adjustments.

The composite index of indicators, a broad measure adjusted for seasonal variations, rose to 51.7, up from 51 in September. October was the second consecutive month that the index surpassed the 50 level, having stayed lower for a seven-month period. A reading below 50 indicates that the economy is contracting. A reading above 50 indicates that it is expanding.

The report is based on a survey of purchasing managers at 250 major companies in 21 industries.

Production showed little change. The study indicated that 26 pct of the respondents noted that output was up, compared with 23 pct in September. Twenty pct indicated that production had declined compared with 17 pct the previous month.

New orders eased after rebounding in September, the NAPM said. Twenty-seven pct of the managers mentioned an improvement compared with 34 pct in September. Another 27 pct reported a slowdown compared with 20 pct previously.

A slowdown in vendor deliveries that had been noted in September continued in October, according to the survey.

For the eleventh month in a row, more purchasers reported paying lower, rather than higher prices. Also, no commodities were reported to be in short supply and only one product—diesel fuel—was reported to have gone up in price.

Reported as lower in price were corrugated shipping containers, caustic soda, phenol, aluminum, steel and soybean and vegetable oils.

A decrease in lead times for capital expenditures was also reported for October. The number of respondents reporting lead times of six months and longer decreased in the tenth month to 48 pct from 52 pct in September. However, the NAPM noted that lead times for production materials lengthened.

–Ed Bowers

the ninth month fell 40 pct. In August orders declined 8.3 pct compared with July.

Machine tool shipments during September rose 12 pct from their August level to a total value of $242.5 million. That shipment rate was 15 pct above the rate one year ago. The excess of shipments over orders resulted in a sharp, $71 million, decline in the industry's backlog of unfilled orders.

During September, orders for metalcutting type machine tools, which were 46 pct below last September's rate and declined 8 pct from their August level. Metalforming machine tools orders, off 21 pct from last year were off 5 pct from August.

Shipments of metalcutting type machine tools rose 21 pct during September to a rate that is 15 pct higher than it was one year ago; while metalforming shipments, which slid 5 pct during the month, reached a total that is 16 pct higher than it was one year ago.

"In 1981, President Reagan led us to a pro-expansion, pro-investment, pro-savings tax program that, once it took, led us out of the recession," said Mr. Gray. "Even the machine tool industry, always one of the last to recover, was showing signs of rejuvenation, as evidenced by the growth in shipments.

"Falling orders and backlogs are the clear result of the Congress' and Administration's protracted proposals and discussions of changes that would gut the salutary effects of the 1981 tax law. What began as an approach to developing a fair and simple tax code has turned into a dog-eat-dog battle for tax revenues at the expense of business, savings, investment and economic growth. As Congress debates, business investment plans languish, while capital purchases to create jobs, increase competitiveness and provide for future growth, are deferred." ***–Ed Bowers***

WEST

Rockwell Hit With Suspension On Government Work

The nation's second largest defense contractor was suspended in November from receiving new government contracts or renewing existing ones in a sign that the military is continuing to come down hard on its major suppliers.

Rockwell International, which is based in Pittsburgh but performs much of its high-visibility aerospace work in California was suspended for at least 30 days from receiving government contracts after company officials had pleaded guilty to 20 charges of false billings and had admitted overcharging the service.

The overcharging incident is more than three years old. It involves Collins Communications System, a Rockwell subsidiary based in Texas. In its investigation of the incident, the government claimed in court papers that six company employees took part in a plan to file phony time cards that covered work done on an automated data processing system used on the EC-135 airplane. The total contract was valued at $3.6 million.

In announcing the suspension at a Washington press conference, Air Force Secretary Verne Orr told reporters that he expected it to be temporary.

But he warned: "I'll keep it in effect until I'm sure that Rockwell has taken all steps necessary to safeguard against a recurrence."

Rockwell was given 30 days to come up with a remedial plan. The Air Force could then lift or extend the ban.

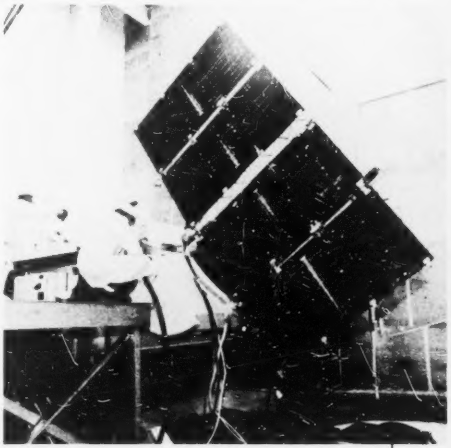
In a similar incident involving General Electric Co. earlier in 1985, the Air Force narrowed the ban involving new contracts to the specific company unit involved in the overcharging incident. In that case, GE admitted to overcharging the Air Force on costs associated with Minuteman missiles. Eventually the limited ban was lifted.

Even so, the announcement stirred the defense community, since it was obviously taken for wide public attention.

Mr. Orr went out of his way to tell reporters it was designed to "send a clear signal that the Air Force simply won't tolerate this or any other kinds of fraud regardless of the size of the contractor."

Rockwell is the nation's second largest defense contractor. Government sales totaled $6.2 billion during the 1984 fiscal year. Total company revenues were $11 billion.

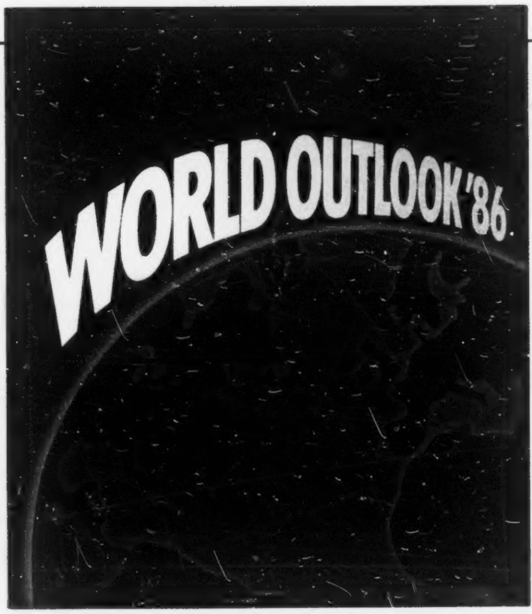
The company builds three status and highly visibile projects: the B-1 bomber, the space shuttle and the MX missile. It also manufactures Army missiles, the Navstar global positioning satellite and other expensive weaponry.



Global Positioning System 12, the first production satellite developed by Seal Beach's Satellite Systems Div., Rockwell International Corp., is designed to transform the sun's energy into electric power.

Company officials said little about the Air Force action, except to note that Mr. Orr said Rockwell "has fully cooperated with us and has been forthcoming in all aspects of the investigation."

The company issued a statement that noted, "We have been cooperating fully with the Air Force and will continue to do so. We look for an early resolution of this matter.



The driving force that has powered the world's economic engine into overdrive during the past few years is in need of a tune-up.

The United States, while keeping the global motor purring by importing a vast portion of its trading partners' exports, has, in the meantime, run up over a $100 billion trade deficit that is compromising its economic vitality.

The driving force will be out of service for awhile as repairs that began in 1985 continue throughout 1986. An alternative power source now must be found to keep the engine running at peak efficiency.

PRODUCTION'S 1986 world-wide survey of the leading industrialized nations indicates an upcoming period of slow growth for most countries, and stagnation for others. The declining value of the dollar, coupled with a growing protectionist movement are two key factors already slowing the volume of imports entering the U.S. Moreover, escalating pressure from Washington directed at U.S. trading partners to open up protected markets is realizing some success.

A Slowing On The

A PRODUCTION MAGAZINE STAFF REPORT

The U.S. is one of the three most important trading partners of each of the Pacific Basin nations, importing close to half of their annual exports. Because the U.S. can no longer absorb the wave of foreign products landing on its shores, the Pacific Basin countries will sputter this year and in the foreseeable future. They will have to regroup. Internal consumption will have to be increased and new markets must be sought in order to fill the void left by the U.S. as it attempts to harness its runaway trade deficit.

The European industrialized nations, on the whole, continue to show signs of recovery, and in some cases, slow growth rates following the stagnating effects of the world recession during the early 1980s. France, a technological powerhouse, for example, has yet to recover from the recession. To further compound matters, France—as well as the rest of Europe—must face the reality of increasing competition from Japan, and eventually South Korea, especially in the machine tool industry.

The Soviet-bloc countries that comprise the Council For Mutual Economic Assistance (Comecon) are showing signs of slow, steady improvement. Comecon is experimenting with policies that it hopes will improve its standing in the world market. Following November's U.S.-U.S.S.R. summit meeting in Geneva, political tensions have begun to ease which should open the door further for trade agreements between Comecon and the U.S.

Trend Horizon

United States

How long will the recovery last? That's the big question for U.S. manufacturers and for that matter the rest of the world.

Considerable uncertainty abounds in U.S. manufacturing circles.

Uncertainty about low interest rates and massive federal deficits. Uncertainty about continued consumer spending in the face of historically high consumer debt and uncertainty about federal monetary policy in the face of growing trade deficits, surging imports and a strong dollar. But most of all, uncertainty about historic recessionary/recovery cycles.

CAUTIOUS OPTIMISM APPEARS TO BE the primary sentiment of economists and corporate officials who have surveyed the 1986 economic landscape in the United States.

Few are predicting a major recession. Or for that matter, any major changes in the economy that was inherited from 1985. Many forsee the continuation of the recovery that began to assert itself in many corporate sectors early in 1984. But enough uncertainty abounds to make even the most confirmed optimist a bit skittish. Most officials are hedging their bets.

Uncertainty about low interest rates in the face of massive federal deficits. Uncertainty about continued consumer spending in the face of historically high consumer debt. Uncertainty about federal monetary policy in the face of growing trade deficits, surging imports and a stubbornly strong dollar. And most of all, uncertainty about historic recessionary/recovery cycles.

"We see a pattern of slow growth, but no recession," one Commerce Department economist explained. "Generally speaking, the economy is in a position where we have a very good outlook. The big negative is the foreign sector, where we are not competing effectively and giving up our market share."

What concerns many economists and corporate planners over the longer term is the general rule of thumb that postwar economic recoveries have traditionally lasted three years and have been followed by a recession.

Following this historic timetable, 1986 should mark the dawn of another cyclical economic downturn. But most believe this historic pattern won't be strictly followed. The last recession was actually a double-barreled affair that began in 1980, ended in 1981 and then returned with severity in mid-1981 and lingered for 18 months.

"That one was a lulu," one Commerce Department official explained. "It was deeper and longer than average. And that means it could be a long recovery."

As a result, many officials believe, the resulting recovery that began in 1982 may actually have another year or so to run before it peters out.

This view is bolstered by the fact that the traditional harbingers of an economic downturn, a buildup of inventory and high inflation, haven't yet appeared.

Nevertheless, there is general agreement that the economy could use a boost if the recovery is to continue. The National Machine Tool Builders' Association, in a business activity report released in late September, noted:

"The recovery is now in its 32nd month and, to maintain or expand its momentum, needs a new economic catalyst or release from the structural constraints. . .characterizing this upturn.

"Unfortunately, neither the Congressional deficit reduction package nor the proposed tax simplification program seems likely to provide such impetus."

The NMTBA report concluded: "In the final analysis the watchword is caution. . .Of particular concern is the lack of significant strength in those sectors of the economy that are still growing, and the likelihood of continued weakness in the many areas of the economy that are faced with stiff import competition."

Despite all the uncertainty, there is one, giant certainty in 1986: There will be an election come November.

And that has convinced many pragmatic executives and planners that even a worst case economic scenario will be pretty bearable because, no matter how bad things may get, they are not going to be allowed to get that bad, at least until after November.

And after that? Robert J. Eggert, president and chief economist of Eggert Economic Enterprises, which publishes the Arizona-based *Blue Chip Economic Indicators* newsletter, told the NMTBA annual convention that his consensus forsees the next recession beginning not until very late 1986 or early 1987.

"The latest Blue Chip consensus suggests that the green light for economic growth and stable inflation still prevails for the year ahead," Mr. Eggert said.

He predicted on the whole 1986 would end up being a good year, though not a great year.

Status Quo Outlook

Many industry officials seem to believe 1986 will allow many corporations to continue trimming, acquiring, merging or otherwise repositioning for the next period of economic gloom. In the interim, business actually looks pretty good, even in some of the industries that were torpedoed during the last downturn.

Take the computer software industry, which had its share of ups and downs in 1985.

Norman Block, the executive vice president and chief financial officer for California-based Ashton-Tate Corp., spoke words common to many industries this new year, at least from the executives who are speaking for the public record. Said Mr. Block: "Industry sales should be higher, but they will be growing at a slower rate. And we anticipate Ashton-Tate to outpace the industry rate."

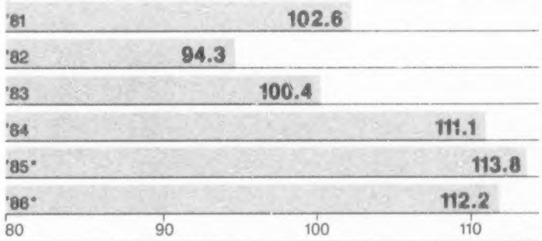
Cautious optimism for your industry, strong enthusiasm for your company. That seems to be a general trend in the executive boardroom this year.

UNITED STATES

Gross National Product (GNP): $1.6 Trillion (1984)

	'81	'82	'83	'84	'85*	'86*
GNP *Trillion Dollars*	1.5	1.4	1.5	1.6	1.7	1.7
Foreign Trade *Billion Dollars*						
Imports	261	244	258	328	360	N/A
Exports	232	209	199	220	217	N/A
Trade Balance	– 28	– 35	– 59	– 108	– 143	– 150
Durable Goods Production *Billion Dollars*	1,006	920	1,019	1,182	1,200	N/A

Industrial Production Index-Mfg.
Base 1980 = 100



**Estimate, PRODUCTION Magazine*
N/A—Not Available
Source: U.S. Department of Commerce

So, too, in the auto industry. L. R. Windecker, Ford Motor Company's research and analyst manager, forsees greater import penetration of the industry, a slight decline in U.S. car sales overall, but a pretty good year for Ford.

"Car sales in 1985 should wind up at about 10.8 million," said Mr. Windecker. In 1986 we expect them to be more than 10 million, but less than 10.5 million."

He believes that Ford will hold onto its overall share of the market, which has been hovering at slightly below 20 pct.

"Imports will increase in both volume and market share," he added. Additional foreign manufacturers are entering the American market at the same time more established foreign automakers are expanding their range of product offerings.

Imports, which captured approximately 27 pct of the market in 1985 should increase their share by an additional percent or two.

Booming Defense Industries

Actually, the amount of executive enthusiasm in 1986 appears to be directly proportional to a company's distance from Uncle Sam's lucrative contracts.

Officials in the defense and aerospace sector are more upbeat—jubilant might be the more accurate term—than their contemporaries slugging it out in decidedly less gentlemanly endeavors like steelmaking, shipbuilding, and other basic, heavy industries.

Aerospace and electronics have settled into a positive trajectory in 1986. There is no place to go but up in the Reagan Administration. Most major defense projects are firmly established, and 1986 orders are in the pipeline. Assuming the weapons work—and in a few well-publicized 1985 cases in which they didn't—these executives have little to worry about.

A company like St. Louis-based McDonnell Douglas Corp., has the best of both worlds. Commercial airplane sales at its Douglas Aircraft subsidiary in California are booming while government sales of missiles and combat aircraft are holding steady. Slumping computer operations, with declining sales of hardware and software to business and institutional customers, is the only soft spot.

On the whole, new business, more expansion, and additional hirings are anticipated, at least at the Douglas subsidiary.

This is a far cry from the dark days of 1984 when the parent company scrapped a batch of new aircraft programs and cut the employment rolls. The doomsdayers thought Douglas might follow Lockheed right out of the commercial airplane business. Instead, 1986 should see Douglas employment grow from 20,500 to 24,000.

Fueling the growth are both commercial airplane sales and a new military project: The C-17 cargo plane. Douglas expects to deliver 105 new airplanes in 1986, mostly MD-80s, the popular new 165-seat passenger jet. Some 86 were delivered in 1985.

Orders for new commercial jets should increase, too, accenting a trend that took hold in 1985 when passenger airline loads increased, airline profits returned and the companies began purchasing jets to replace their aging fleets. Officials are busily marketing derivative versions of the MD-80, and are nearing a decision to launch a new MD-11 commercial jet program. The MD-11 is a derivative version of the DC-10 jumbo jet.

At the same time, Douglas expects increased military sales, especially for the $16 billion C-17 Air Force transport program. With initial production now scheduled for 1987 and approximately $380 million targeted for spending in 1986, company officials are optimistic.

"It's a damn bullish outlook," said David B. Eastman, manager of media relations. "We're just pushing at the gills right now."

The company is quadrupling manufacturing space for the C-17 this year, leasing 1 million sq. ft. of additional warehouse space and is considering constructing a new, eight-story 60,000 sq. ft. office building.

Seattle-based Boeing Co., which landed a $3.1 billion order from United Airlines for new commercial jets and a $2 billion order for aircraft from Northwest Orient at the end of last year, also expects its production lines to hum this year.

That will have a strong, positive ripple effect on the web of subcontractors and parts suppliers that comprise the supply pipeline for military and commercial aviation.

California-based Lockheed Corp., which is concentrating on government contracts, is similarly optimistic about 1986.

"With the phasing out of our commercial airliner program, which is now completely finished, we are now virtually exclusively dealing in military aircraft programs," explained James W. Ragsdale, director of corporate public relations for Lockheed-California Co., a major subsidiary.

"Our hiring and planning for the future depends upon the level of military contracts we have, both from the U.S. government and our foreign customers. We think that in 1986 all the programs we have now will continue."

These include the Navy P-3 Orion and S-3 Viking antisubmarine warfare patrol plane and reconnaissance aircraft like the TR-1 and SR-71.

Employment at the Lockheed-California subsidiary, which stood at 17,200 at the end of 1985, is expected to increase by several hundred. Lockheed has been channeling more funds into research and development and plant facility expansion. Lockheed-California anticipates spending approximately $100 million in these areas in 1986.

The parent Lockheed Corp. plans to spend $5 billion between 1985 and 1990 on capital projects and company-sponsored research and development. These include construction of new research facilities at the Kelly Johnson Research Center north of Los Angeles and in Sunnyvale, where its missile and space operations are centered. That division landed a preliminary contract late last year that eventually could lead to a multi-billion dollar, five-year long "Star Wars" contract.

Lockheed, like Northrop, Hughes, Rockwell and TRW and other aerospace and electronic giants, is involved in sensitive government work on a potpourri of futuristic, multibillion dollar projects that range from the Star Wars missile defense system to the space shuttle, the Stealth bomber and the Advanced Tactical Fighter.

Many of these programs are in their initial development stages, and it's unclear which key players will wind up with a chunk of that super-secret project. The situation could become clearer by the end of 1986.

Outside the defense electronics area, economic prospects are a good deal less sanguine. Again, the ripple effect from the defense sector will compensate for weaker business segments, aiding major companies involved in both consumer and government related manufacturing.

Take Signal Companies of La Jolla, which merged into Allied-Signal Corp. in 1985 and has been consolidating its operations since. Officials predict major operations will benefit from defense spinoff business this year. The consumer oriented end of the business is less certain.

The Ampex electronics subsidiary has slumped from depressed sales in the personal computer segment of the high technology industry.

"The computer peripheral business has been pretty much on its ear," said Dan Derbes, executive vice president for Allied-Signal. "A lot of our customers have gone broke."

But Ampex also supplies professional audio and video equipment, and this business segment has been enjoying a moderately strong growth rate.

"We're pulling back on product introductions and battening down the hatches," said Mr. Derbes. "We don't see any big surge next year, but we also don't see any big downturn, at least through the first three quarters."

Signal's Garrett Corp. subsidiary in Los Angeles also forsees a skewered business situation next year. Its aerospace and commercial jet products should enjoy increased demand. But product demand for the general aviation and automobile markets should be flat.

"We should be up about 5 pct in real growth," said Mr. Derbes. "Employment will stay flat. Generally Allied-Signal is trying to consolidate, eliminate duplication and eliminate excess overhead costs. We're trying to reduce our staffing particularly in our administrative functions."

That cautious approach is mirrored throughout the high technology and manufacturing industries.

"We think 1986 should be a return to a "near-normal" year," said Richard O'Brien, corporate economist for Hewlett Packard Co.

"People are going to be cautious. We won't see a boom year like 1984, but we should see something that will look respectable."

Mr. O'Brien said 1985 marked a true recession for the electronics industry, despite the general economic upturn. Employment at H-P was stable, but in August the company began requiring employees to take two days off per month without pay. Shutdowns were ordered for Thanksgiving and Christmas holiday periods.

Mr. O'Brien believes the market won't further deteriorate in 1986. But he's unsure how much improvement there will be. "People are going to be cautious," he explained. "Things aren't getting any worse, but they aren't going to be getting any better."

H-P will again strive to avoid layoffs, but payless periods could reoccur. A hiring freeze is in effect. One sign of optimism: The firm is undertaking an aggressive college recruitment drive in 1986.

Restructuring

Restructuring and cautious optimism also predominate in the oil and gas industry. Officials at Los Angeles-based Atlantic Richfield Co. (ARCO) plan to turn their attention more to the discovery and production of oil and gas and less toward the downstream refining and marketing ends of the business. The company also will continue its ambitious restructuring effort begun in 1985.

"The sale of our non-coal minerals assets will be progressing in 1986," explained Al Baker, ARCO's manager of integrated planning. "The focus will be on oil and gas exploration and development, areas that we can handle more efficiently."

The outlook for the oil and gas industries, especially in the refining and marketing areas, appears uncertain.

"We expect there to be a continuation of the current oversupply situation," said Mr. Baker. "It is likely to extend through to the end of the 1980s."

Pacific Basin

The strength of the yen in 1986 should slow the rate of export growth for Japan.

In China, where the industrial sector has rolled along at a fever pitch a slowing trend should be in evidence as the government moves in to cool things down.

In Korea and Taiwan, two countries that rely on heavy export trade with the United States, there is cause for concern this year.

JAPAN

In the absence of government action to stimulate domestic demand, the Japanese economy will experience a major slowdown during 1986 as major export-oriented industries will feel the adverse effects of a greatly strengthened yen in relation to the U.S. dollar.

Manufacturing output, which grew 6.5 pct in the first six months of 1985, is still expected to exceed 5 pct for the full year. The current expansion of business activity, which dates back to 1983, is expected to peak by year-end, and most economists now feel productivity will increase by only 1 pct in 1986. Earlier estimates predicted 3 to 5 pct growth.

With the government committed to a program of fiscal reconstruction, it appears highly unlikely at this time that any major public works initiatives will be forthcoming. In part, because of this fiscal policy it is believed a slowdown could last for up to two years.

To a large extent the current situation stemmed from a September meeting of the "Group of Five" industrialized nations, which included the U.S. and Japan. The end result of that meeting was a commitment to drive down the value of the dollar in relation to other world currencies.

Prior to the announcement the dollar, in relation to the yen, stood at 240 yen. It subsequently has dropped to levels approaching 200 yen, as of November. The Bank of Japan earlier had indicated a target of 200 to 210 yen. There now are indications, however, the central bank may try to drive the dollar down to levels of as low as 190 yen.

The major effect of the weakened dollar is being felt by Japan's major export-oriented industries such as automobiles and electronics. The Japanese auto industry presently exports more than half of its annual production, of which 45 pct of total vehicle exports are shipped to the U.S.

The exchange losses are expected to be quite significant despite the fact that the industry—as well as Japan's highly charged electronics industry—remains fundamentally sound.

Hardest hit, however, will be industries such as shipbuilding which even prior to the sharp fluctuation in the exchange rate had begun to lose their international competitiveness.

Economists are suggesting that a rate of 200 yen to the dollar (from 225 yen) will bring about a 1.8 pct decline in the growth rate of Japan's real GNP. As a result, manufacturers already have begun to cut back on their planned spending for new plants and equipment. Capital investment by private sector firms is now expected to drop by 1 to 2 pct during the first quarter of 1986 compared with Jan.-March 1985.

Industries which may benefit from a stronger yen are utilities (electric power and gas), petrochemicals and petroleum. Gains, however, are likely to be offset somewhat by what is happening in other sectors. If, for instance, Japan goes into a recession, the demand for electricity invariably will decline.

CHINA

A country with close to one billion consumers admitting that it must increase its trade with the world market to stimulate industrial growth would appear to be the ideal trading partner. China is on the verge of becoming such a market.

Long content with remaining isolated from the world market, the country has announced a program of major economic reforms that include further opening its doors to stimulate trading ties with western industrialized countries.

From 1982-84 China's industry grew at a average rate of 10.6 pct compared to 7.1 pct for the period 1979-84. During the first six months of 1985 China recorded an overall industrial growth rate of 23 pct—a figure that China's leaders said must be reduced to a more "appropriate" growth rate level in the future. As adjustments are made during the latter part of 1985, the industrial growth rate should come in at around 12 pct.

China will release its Seventh, Five-Year-Plan later this month. And preliminary reports indicate a growth rate target of 7 pct in GDP, and a 12 pct increase in foreign trade. Considering the projected 1985 percentage, a more realistic growth rate for the next five years should hover around 10 pct.

Since 1981 the country has attained a trade surplus. The value of its trade in 1984 was close to $54 billion. Exports increased 17 pct to 27.4 billion, and imports 29 pct to 26.7 billion. Japan, Hong Kong, the U.S. and the European Economic Community are China's principal trading partners.

China's trade with the U.S. declined from a 1981 high of $5.5 billion to $5.2 billion in 1982 and $4.4 billion in 1983 due to a substantial reduction in U.S. agricultural sales stemming from China's decision to cut back imports because of both countries' failure to reach a new textile agreement.

Since 1982 one industry that has posted rapid growth is its machine tool industry. Machine tools accounted for more than 30 pct of the gross value of output. By the end of 1982, growth increased 15.9 pct and surged another 21.1 pct in 1983. The growth hinged on a strong demand for machinery in agriculture, energy, transportation and construction industries.

There are about 500 types of machines exported from China. Small hydropower generators are making inroads in the world market. In 1985, China exported more than $100 million worth of electronic equipment. The products included sophisticated electronic instruments, systems and technology which have replaced electronic parts and components.

Imports of machinery and equipment have also increased. In 1984 China signed 150 contracts to import machinery equipment, 36 pct more than in 1983, representing $120 million. Major machine imports include: machine tools, forging presses, test equipment such as meters, test instruments and gauges, low energy consumption equipment, water pumps, air blowers, compressors, internal combustion engines and computer software. Imported technology has meant higher standards of Chinese machinery. During the Seventh Five Year Plan, more emphasis will be centered on importing manufacturing technology for energy exploration, general machinery and controls, automatic controls and testing equipment. China has indicated that any manufacturer who will transfer technology will be given preferential treatment.

China's surplus trade balance has decreased over the past two years and in 1985-1986 will show a slight deficit. China's planning agencies have called for faster growth in imports and a gradual expansion of the trade deficit. Trends established in 1983 indicate that China is increasing purchases of equipment and technology to meet short-term requirements and to support industrial growth to meet its long-term goals of modernazation and increased productivity. However, China's decline in its foreign exchange reserves has raised caution. The government recently moved to ban most import vehicles for two years to reduce the flood of Japanese cars entering the country. The government would rather see joint ventures with foreign companies.

Regarding imports, China's leadership is encouraging such businesses as machine tools, electronic components, iron and steel, and components to invest in state-of-the-art foreign technology, in addition to establishing joint ventures with foreign manufacturers.

China's steel industry imports more steel than any other country in the world aside from the U.S. China is the fourth largest steel producer in the world but it still must rely on imports to satisfy demand.

The country is currently in the midst of an extensive investment in its steel production program projected to reach an 80 million tons per year by the year 2000. To reach this goal, China will need to rely on foreign technology and equipment to modernize its existing facilities.

KOREA

The strength of the Korean economy closely mirrors its export trade to the United States, the predominant buyer of Korean manufactured goods. Because the U.S. trades heavily with Korea—as well as with all Pacific Basin countries—the last few years have witnessed substantial growth in Korea's economy relative to increased volume of exports to the U.S.

The U.S. is one of the three leading trading partners of every Pacific basin nation. The region has now surpassed Europe in importance in overall U.S. trade.

In the past, Korea sold approximately 30 pct of its exports to the U.S. In 1984 that figure grew to 35 pct, a sizable increase considering the U.S. is presently one of the few consistent markets in the world today. As more and more developing countries vie for a greater slice of the American market the increase in Korea's export percentage is noteworthy.

There is cause for concern. Korea fears that it will begin to lose its edge in trade with the U.S. because of competition from suppliers of similar products. A slow growth rate is expected in 1986 because of a saturation of exports into the U.S. market while the dollar remained high.

Another important factor relative to the general health of Korea's economy is the fact that the country's imports continually exceed exports, resulting in a continuance of its foreign trade debt. However, Korea does not view the debt as ominous because its long-term viability depends on foreign trade.

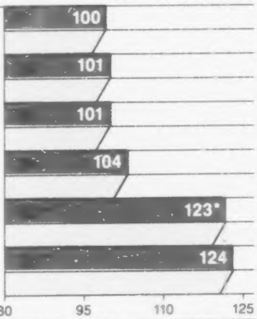
Since 1981, Korea's trade deficit has decreased from $4.9 billion in 1981 to about $300 million in 1985. At the end of 1986, Korea projects a slight surplus. One reason for the decreasing debt is Korea's movement into the manufacturing of high technology

JAPAN

Gross Domestic Product (GDP): $1.2 Trillion (1984)
Exchange Rate U.S. $1 = .005 Yen

	'81	'82	'83	'84	'85**	'86**
Wage Cost-Mfg. *Base 1980 = 100*	100	105	110	120	N/A	N/A
Foreign Trade* *Billions U.S. Dollars* **Imports**	143	132	126	138	123	193
Exports	152	138	147	169	176	133
Trade Balance	+9	+6	+21	+31	+53*	+60

Industrial Production Index - Mfg.
Base 1980 = 100



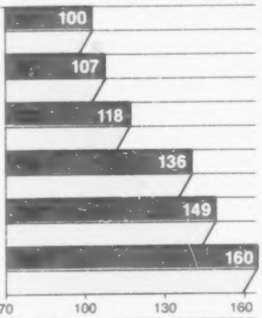
*Total Year **Projections N/A—Not Available
Source: U.S. Commerce Department

CHINA

Gross Domestic Product (GDP): $272 Billion (1984)
Exchange Rate U.S. $1 = $3.1 Yuan

	'81	'82	'83	'84	'85	'86**
Wage Cost-Mfg. *Base 1980 = 100*	N/A	N/A	N/A	N/A	N/A	N/A
Foreign Trade* *U.S. Dollars* **Imports**	19.3	17.9	19.6	26.7	25.5**	N/A
Exports	21.5	22.9	23.5	27.4	24.4**	N/A
Trade Balance	+2.2	+5.0	+3.3	+0.7	−1.1	N/A

Industrial Production Index - Mfg.
Base 1980 = 100



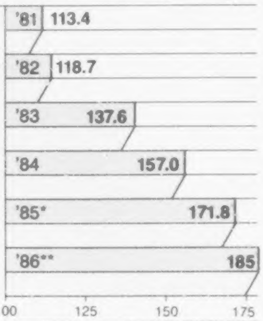
Source: Organization of Economic & Cultural Development
*Total Trade N/A—Not Available
**Projections

KOREA

Gross Domestic Product (GDP): $84 Billion (1985 Est.)
Exchange Rate U.S. $1 = 900 Won

	'81	'82	'83	'84	'85	'86**
Wage Cost-Mfg. *Base 1980 = 100*	N/A	N/A	N/A	N/A	N/A	N/A
Foreign Trade* *Billions U.S. Dollars* **Imports**	26.1	24.2	26.1	30.6	29.2	32.0
Exports	21.2	21.8	24.4	29.2	29.0	32.0
Trade Balance	−4.9	−2.4	−1.7	−1.4	0.2	0.0

Industrial Production Index - Mfg.
Base 1980 = 100



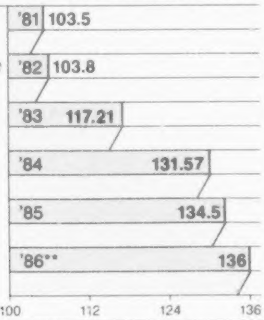
Source: Organization of Economic & Cultural Development
**Total Year*
N/A—Not Available
***Projections*

TAIWAN

Gross Domestic Product (GDP): $65.9 Billion (1985 Est.)
Exchange Rate U.S. $1 = 39.0 Taiwanese Dollars

	'81	'82	'83	'84	'85	'86**
Wage Cost-Mfg. *Base 1980 = 100*	N/A	N/A	N/A	N/A	N/A	N/A
Foreign Trade* *Billions U.S. Dollars* **Imports**	21.2	19.2	20.3	22.0	25.8	31.0
Exports	22.6	22.2	25.1	30.5	34.0	38.6
Trade Balance	+1.4	+3.0	+4.8	+8.5	+8.2	+7.6

Industrial Production Index - Mfg.
Base 1980 = 100



Source: Organization of Economic & Cultural Development
**Total Year*
N/A—Not Available
***Projections*

items such as electronics and machinery which are being exported. In addition, Korea exports about 30 pct of its annual steel production. Moreover, revenues from its emerging automobile industry are expected to make up for any trade loss in other manufacturing areas.

Regarding Korea's machinery production industry during the past few years, exports in 1981, for example, totaled 23 pct of total exports. Exports in 1984 totaled $829 million. In 1985, exports increased 30 pct to $1.07 billion. The forecast for 1986 is for machinery exports to total $1.3 billion. Major export items include automobiles, power generating machines and electrical machinery. On the other hand, machinery imports were up 4 pct over 1984 to $2.1 billion.

Because competition for a share of the U.S. market is on the upswing from emerging countries, Korea has plotted a course to focus its attention on the high-tech arena. Evidence of this shift can be observed in the country's production and exporting of machine tools, electronic equipment and automobiles.

In fact, Korea's move into the automobile industry is projected to be the leading export earner in the future. Later this year Korea will begin exporting its first of 100,000 subcompact cars to the U.S. In 1987, still more cars will land in the U.S. due to a cooperative agreement between General Motors Corp. and Daewoo Corp., Ltd. Already U.S. manufacturers have entered into contracts with Korean manufacturers for the production of such items as batteries and brake components.

The outlook for an increasing number of U.S. machine tool manufacturers in the Korean market is favorable since machine tools are listed for direct import status starting in 1986. Recently, Korea announced that it would lift import controls on 603 manufactured products and open up 102 industrial sectors to foreign investment over a three-year period beginning this year.

The further relaxing of Korean import controls is important considering Korea is on the verge of several major construction projects which include: a new international airport, two additional nuclear power plants, high-speed passenger and freight rail systems, and additional water and sewage treatment plants. A new steel plant is scheduled to open in 1987 that is expected to increase the country's total steel production by 2.7 million tons per year. Current output is about 13 million tons per year.

TAIWAN

Following Taiwan's robust economic activity in the early 1980s, 1986 appears to be the beginning of a period of very slow growth. Taiwan is in the early stage of its transformation from a manufacturer of textile products to a more highly-capitalized and technological-based industrial economy.

The significant expansion of exports has played a vital role in Taiwan's growth during the 1960s. From 1961 to 1971, exports increased 22 pct annually, and from 1971 to 1981, 19.2 pct. Taiwan's rapid growth was due to a prosperous world economy in the 1960s combined with its rapid transition from an agriculture-oriented to an industry-oriented economy.

During 1984, Taiwan focused on trading to the U.S. market, which imports about 50 pct of Taiwan's exports. Major exports include: electronic and electrical products, textiles, machinery, sporting goods and footwear. In 1983, electronic and electrical products surpassed textiles as Taiwan's leading export. Total exports in 1985 reached $34 billion and is projected to reach $38 billion in 1986. Taiwan's major imports include raw materials—especially oil from Japan—and industrial intermediates. Machinery purchases comprise about 25 pct of the country's imports.

Taiwan's export strength over the years has produced a massive trade surplus which registered a high of $8.5 billion in 1984 but has decreased to $8.2 billion in 1985 and is projected to drop to $7.6 billion in 1986. The 1985 gross domestic product (GDP) was $65.9 billion.

Trade between the U.S. and Taiwan continues to grow. Metalcutting machine tools imported from Taiwan during the first six months of 1985 totaled $78.5 million, a 64 pct increase over the same period last year, according to statistics published by The National Machine Tool Builders Assn. (NMTBA).

AUSTRALIA

The Australian economy is slowly beginning to emerge from its worst recession since the postwar era of the late 1940s. Between 1972 and 1982, the country's economy grew at a 2.5 pct annual rate. The growth rate was just about half the rate it maintained during the 1950s and 1960s.

Australia's emergence from its decade-long slump is due to a number of factors.

Both state and federal budgets were expanded to include new housing construction and public works projects. Reductions of inventories during the recession are just now beginning to be restored. In addition, the 1983 devaluation of the dollar has spurred exports and kept imports at modest levels.

However, high interest rates coupled with concerns that the inflation rate could rise is holding private sector investments down.

Exports of coal and wheat during 1984-85 have been strong.

Australia is one of the world's leading exporters of energy resources, but, again, a global depression in the natural resources market has lowered profits. The production of minerals and energy products contributed 10 pct to the overal GDP and has been responsible for over 40 pct of total export earnings.

Australia has incurred a small deficit trade balance since 1981. Total trade during 1985 was $59.6 billion. Projections for 1986 estimate a $6 billion increase that should bring the deficit to zero balance.

Australia's machinery exports accounts for about 5 pct of total exports. Australia ranked 29th in world machine production and trade in 1984. Exports totaled $6.3 million while imports totaled $84.9 million. The United States exported $7.3 million worth of machine tools to Australia in 1984, down $7 million from 1983.

Western Europe

Look for West Germany to continue to lead the recovery. Inflation is expected to remain at the lowest levels on the Continent while trade to the United States will push ahead steadily.

WEST GERMANY

West Germany currently is the main industrial power in Europe. It boasts steady if unspectacular growth and the lowest inflation rate—2.5 pct—in the world. Like the rest of Europe, it is concerned about how to cope with the challenges of Japan and the U.S. And like other developed countries it is perplexed by the seemingly intractable problem of unemployment—presently running at 9 pct.

After three years of stagnation, mechanical engineering recovered strongly in 1984. Orders are booming and production in 1985 is expected to be 3-5 pct above the 1984 figure. The forecast for 1986 is even better.

West Germany has been a phenomenal exporter during the post-war years. It has been the country's buoyant exports which have pulled the engineering sector out of the trough. This has been done in spite of the damaging metalworking strike in 1984 and industrial action in the printing industry.

The strong dollar has helped West Germany's U.S. exports which rose a staggering 31 pct in 1984. This makes North America the biggest single customer for West German engineering products. The engineering sector was also helped in 1985 by strong investment in the domestic market.

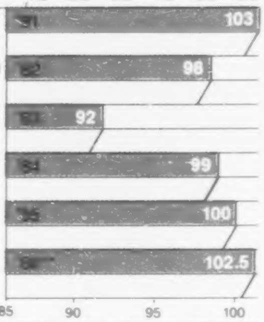
An export drive in the machine tool field has reversed a trend of several years. An influx of machine tools by Japanese machine tool makers caused German builders to abandon 20,000 jobs in the industry between 1980 and 1984. Approximately thirty manufacturers were either swallowed up by bigger and more successful companies or

AUSTRALIA

Gross Domestic Product (GDP): $207 Billion (1985 Est.)
Exchange Rate U.S. $1 = .70 Australian dollar

	'81	'82	'83	'84	'85	'86**
Wage Cost-Mfg. *Base 1980 = 100*	N/A	N/A	N/A	N/A	N/A	N/A
Foreign Trade* *Billions Australian Dollars*						
Imports	20.2	22.9	21.6	27.0	30.1	32.5
Exports	18.4	20.4	21.6	25.7	29.5	32.5
Trade Balance	−1.8	−2.5	0.0	−1.3	−0.6	0.0

Industrial Production Index - Mfg.
Base 1980 = 100



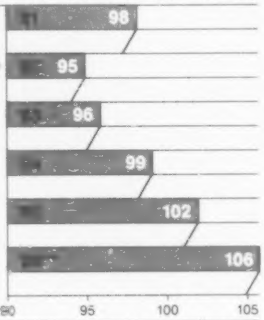
Source: Organization of Economic & Cultural Development
**Total Year*
***Projections*
N/A—Not Available

WEST GERMANY

Gross Domestic Product (GDP): $683 Billion (1985 Est.)
Exchange Rate U.S. $1 = DM 2.6 (Oct. 1985)

	'81	'82	'83	'84	'85	'86**
Wage Cost-Mfg. *Base 1980 = 100*	105	110	113	117	119	121
Foreign Trade* *Billions DM*						
Imports	31	31	32	36	38	40
Exports	33	35	36	41	45	49
Trade Balance	+2	+4	+4	+5	+7	+9

Industrial Production Index - Mfg.
Base 1980 = 100



Source: Organization of Economic & Cultural Development
**Monthly Average*
***Projections*

disappeared altogether. The Japanese product input was particularly strong in CNC lathes and machining centers. German builders were shocked by the sophisticated electronics being incorporated into Japanese machines. A report—never made public—indicated to the Germans where and why the Japanese were making inroads. As a result many German machine tool builders are now concentrating on advanced electronically-equipped machines to combat foreign competition.

The government is now encouraging industry to use more CAD/CAM systems. General Electric Automation has recently opened a big automation center in Frankfurt with the purpose of selling advanced factory automation to industry. Siemens has also launched an ambitious 'megaproject' aimed at making one-megabit chips and, later, four-megabit chips. To speed the development and introduction of these, Siemens has turned to Toshiba for an agreement on knowhow.

In the automotive industry, the big news of the year was Daimler-Benz's takeover of the electrical giant AEG. This will form Germany's biggest industrial company with a turnover in the region of $22 billion. According to Daimler-Benz's chief executive, Dr Werner Breitschwerdt, the aim was to broaden the company's activities into new high-tech fields, particularly micro-technology. He noted that the group had already taken over MTU, the high-performance engine maker, earlier in the year and had also taken a majority interest in Dornier, the aerospace concern. These two acquisitions are believed to have cost the company $384 million and mirror GM's recent aquisition policy in the U.S.

The automotive industry in general has had a troubled time in the last year or two. First, there was the unprecedented metalworkers' strike in 1984, which hit the automotive industry hard, mainly through stopping the flow of components to carmakers. Second, the uncertainty over emissions regulations —caused ironically by the German government's desire to appease its Greenpeace movement—created havoc within the German domestic market.

Both issues have now been settled and companies like Daimler-Benz, VW and BMW will no doubt continue on their path of introducing high automation to combat soaring wage costs. VW is riding high at the moment and is believed to have jumped to the top of the car sales league at mid-1980.

UNITED KINGDOM

The United Kingdom has been improving its competitive position slowly over the last five years against a background of concerns about unemployment, the decline of the manufacturing base and a possible falloff of North Sea oil. Industrial production is recovering from the effects of the debilitating mine strike which occurred in 1984. The latest figures, suggest that in the second quarter of 1985 manufacturing output is running at 2.5 pct above the equivalent figure a year earlier.

The forecast for 1985 is positive with an underlying growth in the area of 2.5-3.0 pct. Whether this can be carried forward to 1986, however, is a dilemma since the U.K. relies heavily on continued consumer spending.

An encouraging sign is the high rate of industrial investment in 1984-85 of 15 pct in real terms. This was pushed higher, however, by the announcement in the 1984 budget that initial tax allowances on industrial buildings and plants were to be phased out. This prompted many companies to announce investment schemes.

The investment of most manufacturers has followed an expected pattern. Plant and machinery—on which the first year allowance has been cut from 75-50 pct—was the fastest growing category at 19 pct in 1984. In the first quarter of 1985 plant investment was up 28 pct over a similar period in the previous year. The other area where there was a healthy investment was in new vehicles for industry, which posted a figure of 27 pct in the first quarter compared with the previous year. Most of the investment was targeted in heavy vehicles rather than cars or vans.

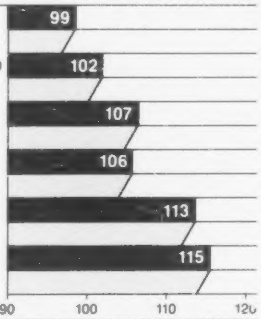
On the basis of past experience, the investment boom could be expected to

UNITED KINGDOM

Gross Domestic Product (GDP): $472 Billion (1985 Est.)
Exchange Rate U.S. $1.41 = 1 pound (Oct. 1985)

	'81	'82	'83	'84	'85	'86**
Wage Cost-Mfg. *Base 1980 = 100*	113	125	137	149	157	162
Foreign Trade* *Billions Pounds*						
Imports	4.2	4.7	5.5	6.5	7.1	8.0
Exports	4.2	4.6	5.0	5.8	6.7	7.1
Trade Balance	0	−0.1	−0.5	−0.7	−0.4	−0.9

Industrial Production Index - Mfg.
Base 1980 = 100



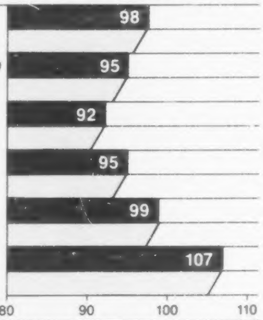
Source: Organization of Economic & Cultural Development
**Monthly Average* *N/A—Not Available*
***Projections*

ITALY

Gross Domestic Product (GDP): $368 Billion (1985 Est.)
Exchange Rate U.S. $1 = 1,774 Lire

	'81	'82	'83	'84	'85	'86**
Wage Cost-Mfg. *Base 1980 = 100*	123	144	172	192	210	217
Foreign Trade* *Billions Lire*						
Imports	8,639	9,684	10,167	12,349	14,824	15,937
Exports	7,170	8,271	9.211	10,752	12,074	13,034
Trade Balance	−1469	−1413	−956	−1597	−2750	−2903

Industrial Production Index - Mfg.
Base 1980 = 100



Source: Organization of Economic & Cultural Development
**Monthly Average*
***Projections*

produce good growth in mechanical engineering output. The fact that it hasn't is due to the development of new technology. Put simply, hardware is being replaced by software as industry invests in new manufacturing technology. Much of the capital investment has been diverted away from mechanical to electrical and electronic engineering.

Although there has been a recovery in the British machine tool market of nearly 11 pct in 1984, output is still 40 pct below 1977.

A recent report on the British machine tool industry predicts that imports of machine tools are likely to rise at a faster rate than the increase in production or exports. The market for machinery is expected to grow by 6 pct in real terms to about $1 billion, with imports—accounting for over 60 pct of the market—rising 6.5 pct to $650 million.

The report expects machine tool exports to grow by 3.5 pct to $670 million, though several builders report soaring sales to the U.S. market. U.K. machine tool production should grow by 4 pct to $1.040 billion in 1985 to $1.128 billion by 1989.

By this time, notes *PRS Business Publications*, which produced the report, about 70 pct of the UK demand for metal-cutting and metal-forming machines will be accounted for by NC machines.

Although historically British productivity has been low, it has improved dramatically in recent years with the impact of new technology. The figures show that wage costs per unit of output are rising much more slowly than actual wages.

A noticeable trend over the last two years is for U.S. companies to seek a manufacturing base in the U.K. and the latest example of this, announced in late October, concerns J. I. Case, the U.S. farm and construction machinery maker. The American company is to spend $126 million to transfer a large part of its U.S. manufacturing to Britain. This will reinforce Great Britain's position as the largest tractor maker in the Western world, and could lead to additional exports amounting to $182 million a year by 1990.

ITALY

Italy's emergence from recession took place later than most other countries and is now well underway. In 1984, gross domestic product (GDP) increased by 2.6 pct in real terms, and is expected to be about the same level in 1985. Contrary to previous experience, this has not caused a higher inflation rate. Inflation is currently just over 10 pct, higher than the European average, but below the 15 pct of 1983.

Italy's current major problem is the trade deficit caused by a sharp rise in imports. It was because of this factor that the government devalued the Lira by 8 pct in mid-year.

The more cyclically-sensitive industrial sector has kept pace with the general upswing in the economy although it has tended to expand and contract sharply with manufacturers responding quickly to the swings in demand. The recovery was posted in chemicals, paper, wood and furniture, textiles and metalworking. Capacity utilization in industry increased from 70 to 72 pct in 1983-84, but in the first half of 1985 was still below the pre-recession peak.

An intense rationalization of production is occurring, pushed by the automotive industry. The Italian automobile sector was one of the first users of robots and advanced automation, aimed mainly at counteracting the chronic labor problems of the 1960s and 1970s.

Fiat, via its machine tool arm, Comau, based in Turin, has pioneered automatic assembly. Manufacturer of the Strada cylinder head was completely automated several years ago. Last year, Fiat expanded its Termoli engine plant on the country's Adriatic coast and installed what is claimed to be the most advanced automatic assembly plant in the world. At Termoli, the FIRE 1000 power unit for a whole range of Fiat cars is assembled entirely by a combination of robots and advanced automation.

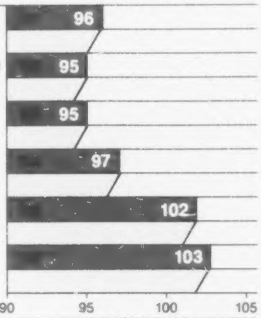
In the machine tool market, Italy has established a strong position for itself. It ranks as the fifth largest producer in the world with annual sales of roughly $1 billion. The industry sells 20 pct of its total production for export.

FRANCE

Gross Domestic Product (GDP): $490 Billion (1984)
Exchange Rate U.S. $1 = 8.1 French Francs (Oct. 1985)

	'81	'82	'83	'84	'85	'86**
Wage Cost-Mfg. *Base 1980 = 100*	112	130	145	156	165	171
Foreign Trade* *Billions French Francs*						
Imports	52	60	64	73	79	85
Exports	48	53	60	71	78	82
Trade Balance	−4	−7	−4	−2	−1	−3

Industrial Production Index - Mfg.
Base 1980 = 100



Source: Organization of Economic & Cultural Development
**Total Trade*
***Projections*

Like most other European machine tool industries, Italy is alarmed at the rising Japanese competition. There also is concern at the possibility of U.S. protectionism.

Another concern is the lapse of an Italian law which in effect provided a valuable subsidy for domestic builders. This was a grant aimed at encouraging plant modernisation and provided up to 25 pct of the purchase of a new machine tool. More help is needed at the present time, said a spokesman, not less. He also noted that the Japanese manufacturing industry receives massive government help in technology and automation.

The worry about U.S. protectionism has as its background the fact that the Italian machine tool industry in 1984 shipped some 10 pct of its exports to North America valued at $52 million.

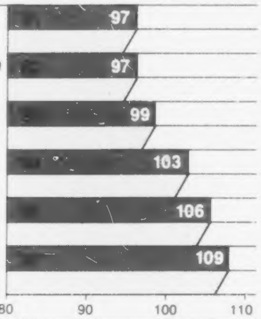
Comau is currently contracted to supply GM plants in the U.S. and Canada with highly-automated assembly lines for aluminium cylinder heads. This will involve about 50 large metal-cutting machines and more than 200 robots.

BELGIUM

Gross Domestic Product (GDP): $85 Billion (1984)
Exchange Rate U.S. $1 = 53 Belgium Francs

	'81	'82	'83	'84	'85	'86**
Wage Cost-Mfg. *Base 1980 = 100*	109	117	124	130	132	N/A
Foreign Trade* *Billions Belgium Francs*						
Imports	192	221	235	266	266	275
Exports	171	199	220	248	261	275
Trade Balance	−21	−22	−15	−18	−5	0

Industrial Production Index - Mfg.
Base 1980 = 100



Source: Organization of Economic & Cultural Development
**Total Trade*
***Projections*
N/A—Not Available

FRANCE

In the post-war years, France transformed itself from primarily an agricultural country to a technological power. In doing so, it enjoyed a phenomenally high rate of growth. Today, it is a world leader in nuclear engineering and a major factor in aerospace, armament and automotive production.

Over the last year or two, however, things have gone sour for France. Although at no time in the last decade has GDP actually decreased, the French economy entered a period of stagnation in the early eighties from which it has not yet recovered.

In 1984, real gross domestic product (GDP) improved by about 1.5 pct supported by relatively buoyant world trading conditions. In 1985, however, growth looks like it is being restricted to 1 pct as international trade slows.

This year is an election year in France and therefore economic policy could get pushed to one side as the political parties manuever for position.

A considerable amount of government-sponsored industrial restructuring has gone ahead in France in recent years, not the least in machine tools. Two state-supported companies, Machines Francaises Lourdes (MFL) and Intelautomatisme, have acted as focal points for rationalization in the machine tool field.

MFL, a specialist manufacturer in heavy machine tools, owned by the state Industrial Development Institute (IDI) and several mainly state-owned industrial groups, is putting its money on a major export drive.

An international sales network has been put in place and MFL chairman, Louis Trady, noted that the current order book guarantees sales of around $62 million in 1985. Orders in mid-1985 were received from General Electric and Westinghouse in the United States and the United Kingdom's Austin Rover Group. Overall, French machine tool orders in the first nine months of 1985 rose by 24 pct compared with the same period of 1983.

Domestic machine tool sales, heavily depressed in 1983, grew by 34 pct in 1984 and exports by 7 pct. More than half the orders were for numerically-controlled equipment.

Like other European machine tool industries, the French are worried about Japanese competition. French officials admit that the government is encouraging Japanese participation in the industry as a means of stimulating domestic companies to boost efficiency.

BELGIUM

After thirty months of virtual stability industrial output picked up strongly in late 1983 and in that year averaged 2 pct growth against a decline the year before. This was the first sign that government policies were impacting the economic neglect of the 1970s when the balance of payments posted deficits year after year.

Observers noted that companies were being under-capitalized. The result was that they were being pushed out of foreign markets. This was particularly serious since 70 pct of GDP is tied to overseas trade.

Foreign trade statistics indicate that from 1981, the foreign trade gap has been cut from nearly $0.5 billion to an estimated breakeven point next year.

One of the main concerns is rising wage costs. In the manufacturing sector, wages have increased more than 30 pct in five years, and in particular against Belgium's main trading partner, Germany. According to Fabrimetal, the industry's competitive position has decreased 9 to 10 pct in the recent past.

The primary problem is inflation. Belgium's inflation rate has been moving ahead at 5.3 pct. Employers complain that the trouble is government-imposed social program costs which are increasing faster than wages. Another common complaint of the business community is that the government's official spending is too high. Certainly, the size of the public deficit has continued to rise in absolute terms over the past few years. It is fortunate that as a proportion of GDP it has started to fall.

The government's target is to reduce the public deficit—currently running at 10 pct of GDP—down to 7 pct by 1987.

NETHERLANDS

Over the past three decades, the development of the Euroports of Amsterdam and Rotterdam have brought the Netherlands unprecedented wealth. A large part of Europe's products now flow through these two main gateways to Europe.

The Dutch economy started to improve in 1983 after the global recession and recovery continued through 1984. The country has a low rate of inflation of 3.2 pct and is one of the few countries with a positive trade balance.

Real GDP is expected to grow by 2 pct in 1985 and manufacturing production is on a marked upward trend—especially metal processing.

Imports of investment goods, raw materials and semi-manufactured goods (together more than 60 pct of total imports) have risen sharply in recent years. However, export volume posted an even stronger growth and continued into 1985.

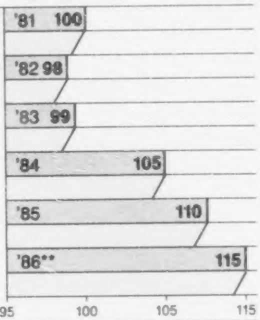
The Netherlands competitive position in the world market has been helped by moderate wage increases as well as by the strong U.S. dollar.

NETHERLANDS

Gross Domestic Product (GDP): $137 Billion (1984)
Exchange Rate U.S. $1 = 2.9 Guilders

	'81	'82	'83	'84	'85	'86**
Wage Cost-Mfg. *Base 1980 = 100*	103	110	113	114	119	120
Foreign Trade* *Billions Guilders* **Imports**	13.9	14.3	14.4	16.5	18.0	18.2
Exports	14.2	14.7	15.3	17.5	19.0	19.4
Trade Balance	+0.3	+0.4	+0.9	+1.0	+1.0	+1.2

Industrial Production Index - Mfg.
Base 1980 = 100



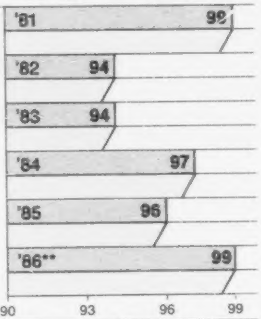
Source: Organization of Economic & Cultural Development
**Monthly Average*
***Projections*

SWITZERLAND

Gross Domestic Product (GDP): $100 Billion (1984)
Exchange Rate U.S. $1 = 2.1 Swiss Francs

	'81	'82	'83	'84	'85	'86**
Wage Cost-Mfg. *Base 1980 = 100*	N/A	N/A	N/A	N/A	N/A	N/A
Foreign Trade* *Billions Swiss Francs* **Imports**	6.0	4.8	5.1	5.7	6.3	7.0
Exports	4.4	4.4	4.5	5.1	5.6	5.9
Trade Balance	−0.6	−0.4	−0.6	−0.6	−0.7	−1.1

Industrial Production Index - Mfg.
Base 1980 = 100



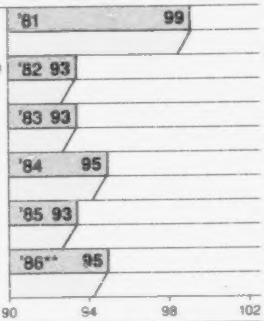
Source: Organization of Economic & Cultural Development
**Monthly Average* *N/A—Not Available*
***Projections*

GREECE

Gross Domestic Product (GDP): $41 Billion (1984)
Exchange Rate U.S. $1 = 156 Drachma

	'81	'82	'83	'84	'85	'86**
Wage Cost-Mfg. *Base 1980 = 100*	127	170	203	256	272	282
Foreign Trade* *Billions Drachma* **Imports**	N/A	10.1	9.5	9.8	N/A	N/A
Exports	N/A	4.1	4.1	4.4	N/A	N/A
Trade Balance	N/A	−6.3	−5.4	−5.4	N/A	N/A

Industrial Production Index - Mfg.
Base 1980 = 100



Source: Organization of Economic & Cultural Development
**Monthly Average* *N/A—Not Available*
***Projections*

The Netherlands has a small but growing automotive industry of which the heavy truck builder, DAF, is an essential part. The main stimuli to this sector, however, will be in 1986 when a new small Volvo, which is built in Holland, is due to come on the market.

Few details of this project are available. It is known however that a new plant has been constructed that will use the latest in car manufacturing technology.

SWITZERLAND

Although Switzerland is better known in the world for its banking and financial services, it is nevertheless a leading engineering country with a bigger share of the world's machine tool market than either France or the United Kingdom. As a machine tool exporter, it ranks second in Europe behind West Germany.

Because of the country's high dependence on exports, it was hit hard by the world recession of the early 1980s and is only now pulling out of it.

Industrial production improved appreciably in 1984 over the previous year and the initial months of 1985 were again boosted by a weakening of the Swiss Franc on international exchange markets.

In mechanical engineering and the metals industry (which account for 50 pct of Switzerland's industrial exports) there were positive signs of growth in the second quarter of 1985, but a pronounced decline in activity cannot be ruled out.

Despite the improvement in exports, the country is still running a hefty trade deficit which, when 1985 figures are complete; is expected to rise to nearly 9 billion Swiss Francs. Fortunately, Switzerland has a healthy invisible trade comprised ma[illegible]y of tourism and financial services. [illegible] should bring the current accoun[illegible]plus to something slightly less than the 7.5 billion Swiss Francs recorded in 1984.

GREECE

The economy in Greece remains more dependent on agriculture than the EEC as a whole. OECD figures show that in 1982 the proportions of GDP contributed by agriculture and industry in Greece were 16.5 and 25.4 pct respectively. Equivalent figures for the EEC are 3.6 and 36 pct. The manufacturing sector is one of the smallest in Europe and has been relatively dormant over the past six years.

The inflation rate has continued to decline, but only gradually. After averaging 21 pct in 1982 and 20.3 pct in 1983, inflation fell to 18.1 pct in December 1984. In the meantime, wages have been rising sharply.

Currently, discussions are proceeding with the EEC on a $2 billion EEC loan to help solve the country's balance of payments crisis. The government has applied to the EEC for a one-year extension on the January 1987 deadline for introducing a Value Added Tax (VAT). Athens also wants to continue restricting the movement of capital.

Over the short term, the outlook is not very encouraging. Critical problems are the need to solve the balance of payments situation, encourage more private investment in industry and reduce inflation.

SPAIN

A policy of rapid industrialization is being pursued in Spain. It has meant restructuring the economy by reducing its dependence on imported energy, and modernizing outdated industries.

Since 1982 the socialist government has pursued tight fiscal and monetary policies. The purpose has been to reduce inflation and curtail deficits in the public sector.

A sizeable trade gap has occurred in spite of a huge increase in exports over the past five years. This has occurred mainly because of corresponding increases in imported goods. Both imports and exports have more than doubled since 1981.

By international standards, productivity and wage costs are low. But wages are rising sharply.

In the strategic sectors of shipbuilding and steelmaking, cuts of around 40 pct have been typical. And in domestic appliance manufacture layoffs have been even more stringent.

Auto building has increased at a rapid pace in importance in the last decade, beginning significantly with Ford's decision to build a major plant at the village of Almusafes on the Mediterranean coast. In 1984, Spain built 1.2 million cars and more than 147,000 farm and industrial vehicles.

The country has become an important automotive exporter, mainly to the already-crowded European market. Apart from Ford, GM has a number of large advanced-technology automotive plants in Spain—as do Citroen, Peugeot, Reanult and Nissan. The national car builder, Seat, is in the process of being acquired by Germany's VW and is making a determined effort to increase its exports.

Spain is a sizeable builder of machine tools. Output in 1984 amounted to nearly $250 million, of which over half were exported. Most exports went to West Germany, France and Great Britain.

A continued gradual acceleration of the economy is expected during 1986. Inflation should level off under the influence of wage moderation and an easing of import prices.

PORTUGAL

Like Spain, Portugal is busy clearing the decks preparing for its entry into the Common Market. In 1984, the government did a good job of reducing the drain of foreign exchange on current account, which proved to be a problem in 1983. However, the trade gap forecast for 1985 is about $2.5 billion, so the position could slip again.

Manufacturing accounts for 40 pct of GDP, more than 66 pct of exports and employs 25 pct of the labor force. However, 50 pct of this manufacturing base is in shoes and leathergoods, textiles, woodworking, cork and ceramics. The only large-scale heavy industry is shipbuilding and repair.

Modernization of industry is being sought over a three- to four-year period in preparation for full integration into the EEC. The idea is to maximize its indigenous natural resources.

Venture capital is to be made freely available to encourage new enterprises. The atmosphere is ripe for incoming manufacturing investment.

There has been some investment already. Portugal's first fully-automated robotized plant which produces small electric motors for sewing machines opened in the town of Ovar in May 1985. The Belgian company, ACEC, holds a 65 pct interest though all the capital was raised in Portugal.

Some 20 electronics companies, many recently established, operate in Portugal. Seventy eight percent of the $470 million invested in 1984 in the manufacturing sector was foreign capital.

As the country inches into the EEC, many U.S. and Far Eastern countries are eyeing Portugal as a possible springboard into the lucrative European market.

Portugal's industrial production index has increased very slowly during the past five years. The country has also incurred a negative trade balance during that same period. Projections call for a $2.5 billion deficit trade balance at the end of 1985.

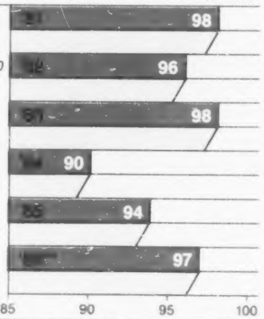
In 1984 Portugal ranked 35th among leading countries in machine tool production and trade.

SPAIN

Gross Domestic Product (GDP): $155 Billion (1984)
Exchange Rate U.S. $1 = 160 Pesetas

	'81	'82	'83	'84	'85	'86**
Wage Cost-Mfg. *Base 1980 = 100*	122	142	163	182	207	217
Foreign Trade* *Billions Pesetas*						
Imports	247	288	348	385	439	N/A
Exports	157	188	236	314	332	N/A
Trade Balance	−90	−100	−112	−71	−107	N/A

Industrial Production Index - Mfg. *Base 1980 = 100*



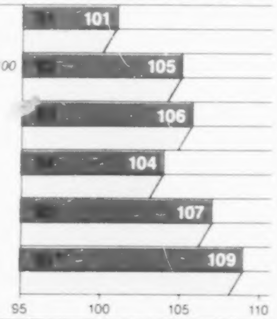
Source: Organization of Economic & Cultural Development
**Monthly Average* *N/A—Not Available*
***Projections*

PORTUGAL

Gross Domestic Product (GDP): $25 Billion (1984)
Exchange Rate U.S. $1 = 162 Escudos

	'81	'82	'83	'84	'85	'86**
Wage Cost-Mfg. *Base 1980 = 100*	121	143	169	199	198	198
Foreign Trade* *Billions Escudos*						
Imports	51	63	74	84	101	N/A
Exports	21	28	42	63	65	N/A
Trade Balance	−30	−35	−32	−21	−36	N/A

Industrial Production Index - Mfg. *Base 1980 = 100*



Source: Organization of Economic & Cultural Development
**Monthly Average* *N/A—Not Available*
***Projections*

Eastern Europe

In the Soviet Union the economic fortunes of the country will be built on the success of the country's Five-Year Plan. Under the new Soviet Premier, industrial productivity, better technology and plant modernization will be emphasized throughout the manufacturing sector.

COMECON

The Soviet-bloc countries that compose the Council For Mutual Economic Assistance (Comecon) are basically in an experimental stage regarding policies directed towards competition in the world market.

What Comecon wants most from the West is high-tech products. But trade embargoes limit the range of many high-tech items that can be sold to Soviet-bloc countries. However, some U.S. companies are examining the potential of interfacing Western machine tools and systems with Eastern-bloc computers and software.

The Soviet Union has hard currency reserves of $10 to $11 billion. A decrease in political tensions between East and West could result in better trading prospects.

Often overlooked by the West is the fact that Comecon countries also have advanced technology to offer in trade. For example, the Soviet Union has developed metallurgical processes and the GDR and Czechoslovakia have had FMS for the past ten years.

There is evidence that trade between Comecon and the U.S. is expanding. Comecon's exports to the U.S. rose substantially in the first five months of 1985 compared to the same period in 1984, from $629 million to $726 million. And U.S. exports to the Soviet Union increased $1.5 billion during that same period with agricultural produts accounting for $1.3 billion of the total.

Poland, however, remains the largest market for U.S. products. Hungary, Czechoslovakia, Romania and Bulgaria have begun to increase trade with the U.S.

U.S.S.R.

The five-year plan from 1986-1990 will require an increase in national income of greater than 4 pct per year. The plan calls for wide changes in the organization of industrial equipment buying policy and management responsibility.

In addition, trade patterns are changing. Exports are declining to the West and the developing countries. New markets for Soviet industrial products may open up following the signing of a five-year trade pact by the Chinese Vice Premier, Yao Yilin with the Soviet Union for the period 1986-1990. Talks are underway between the U.S. and the Soviets with the aim of granting the Soviet Union "most-favored-nation" status. These talks, by U.S. Commerce Secretary Malcolm Baldridge and Soviet foreign trade minister Nikolai Patolichev, could result in increased exports of U.S.-built oil and gas equipment to the country.

In October, 1985, Soviet Premier Gorbachev introduced the new five-year plan to the central committee of the Soviet communist party. It pointed to a 3 pct annual growth rate in light industry and a 7 pct annual growth in services. Mr. Gorbachev emphasized higher productivity, better technology and plant reorganization.

The Soviet Union will not be offering any major contracts to Western suppliers, other than steel plant modernization proposals and, possibly, an automotive engine production technology contract with a Japanese company. The trend will be towards smaller, individual company contracts—one or two machine tools with parts-handling equipment. Soviet management decision-making is changing too. Decision-making is being delegated to lower management levels while factories are being re-organized on a more competitive "price-for-quality" basis.

A potentially-exciting modernization area to Western production equipment and machine-tool suppliers, will be the Soviet truck industry. The GAZ plant is planning a new series of heavy-duty trucks. They want robotization and FMS. All the Soviet truck plants, including ZIL, GAZ, Belorus, Kremenchug and Kamsk, plan moderization and increased output. These plants are looking to the EEC suppliers and Japan (not the U.S. at present) for the latest in production technology. Orders are being placed on a "part contract" basis, machine-tool-by-machine-tool. The overall value will be enormous.

For the Soviet auto industry, Nissan Motor, Japan, is considering a Soviet request to buy the latest Japanese automotive manufacturing technology. The country wants to produce 1500-1600 cc engines at a rate of 100,000-200,000 per year.

Other sectors seeking to modernize are the Soviet agricultural machinery, food processing machinery and energy machinery builders. There could be lucrative contracts in these industries. In iron and steel, Finsider of Italy has picked up three major contracts. Voest-Alpine of Austria is also doing well.

In 1984, Soviet trade with the West rose 6.4 pct while turnover with the U.S. rose 64.7 pct to 3.13 billion Rubles. Japanese trade declined 3.53 pct to 2.89 billion Rubles. West Germany, which stands to do very well in machine-tool and production equipment exports to the country increased its trade with the Soviets by 7.1 pct to 7.5 billion Rubles. Soviet trade also rose with France, Italy, Britain, the Netherlands and Canada.

Increased Soviet sales of natural gas to Western Europe is the main factor behind trade expansion. Western trade accounted for 29.3 pct of total Soviet trade volume in 1984.

In early 1985, exports to non-socialist countries declined 30.7 pct in dollars. Imports declined 4.7 pct. Exports to the developed West declined 36.3 pct in nominal dollar terms in the first quarter of 1985. The decline in energy exports was 42 pct. Soviet imports from the West in the same period declined 2.3 pct (excluding grain deals). Exports to the developing countries fell 19.8 pct and imports fell 11 pct in the first quarter of 1985. The Soviet trade surplus with these countries fell 47 pct when compared with the first quarter of 1984.

Exports to the socialist countries was stymied. However, the indicators for the second quarter, 1985, show some growth of trade in most sectors.

GERMAN DEMOCRATIC REPUBLIC (GDR)

The German Democratic Republic (GDR) possesses few natural resources. Its economy is based on importing raw materials which are then processed into manufactured products.

At the beginning of the 1980s, the GDR set a goal to increase its export trade and limit imports to erase its trade deficits and mounting foreign debt. The policy shift stemmed from the GDR's heavy dependence on Western imports in order to spur economic growth during the 1970s. In 1982 the effect of the policy change resulted in the GDR incurring a trade surplus, its first in many years.

However, the reform measures slowed investments resulting in few goods available for domestic consumption, and put on hold the government's plan to modernize plants and equipment.

In 1984, the GDR recognized that economic growth was reaching a peak, and that major investments in industrial plants were needed causing—many analysts believe—the GDR's accelerated borrowing of hard currency in 1985.

The GDR's current Five-Year Plan (1986-1990) emphasizes industrial modernization and growth in high technology. As recently as eight years ago the GDR had no microelectronic industry. Today, the GDR claims to be almost self-sufficient, having developed production techniques for making chips and components including CNC, DNC, and CAD/CAM systems.

The GDR intends to automate 40 to 50 pct of its mechanical engineering plants, making wider use of FMS, automatic assembly and CAE systems. Net-shape forming technology will be used more to save materials.

During 1984 the GDR invested $307 million in machine tool research and development. In 1985 that figure jumped to $340 million. A $2.9 billion investment is planned between 1986 and 1990.

The construction and chemical industries will also be modernized. Some $230 billion is available for the construction industry between 1986 and 1990. Some of this new technology will be imported from the West, principally, West Germany.

In 1984, the GDR's economy grew by 5.5 pct, the highest per capita income among Comecon countries. Industrial growth stemmed mainly from electrical engineering, electronics and equipment production. Output in these sectors was up 8 pct in 1984 compared to 1983.

About 30 pct of the GDR's national income comes from foreign trade. The Soviet Union is its main trading partner accounting for 40 pct of all exports and imports. Soviet exports to the GDR consist mostly of fuels (particularly oil). Nearly two-thirds of the GDR's exports go to the Soviet Union with machinery and equipment leading the list.

In order to accomplish its goals established in the Five-Year Plan, the GDR will require micro electronics, computer and automation technology, and robot and sensor technology.

BULGARIA

After sluggish growth in 1983, the Bulgarian economy grew 4.6 pct in 1984 only to see 1985 get off to a slow start due to a severe winter, attaining only a 2.4 pct rate of increase for the first six months.

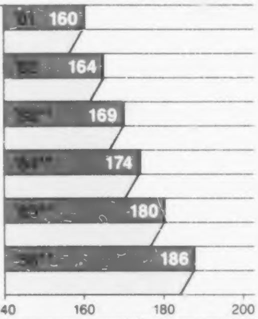
Main industrial growth is in mechanical and electrical engineering, metalworking and energy sales. Above-average growth is reported by manufacturers of industrial robots and manipulators, machine tools, railroad freight

U.S.S.R.

Gross Domestic Product (GDP): $1.6 Trillion (1983 Est.)
Exc nge Rate U.S. $1 = .78 Ruble

	'81	'82	'83	'84	'85**	'86**
Wage Cost-Mfg. *Base 1980 = 100*	N/A	N/A	N/A	N/A	N/A	N/A
Foreign Trade* *Billions U.S. Dollars* **Imports**	25.1	26.3	31.5	33.5	35.5	38.5
Exports	23.9	26.1	27.0	27.5	30.5	34.5
Trade Balance	−1.2	−0.2	−4.5	−8.0	−5.0	−4.0

Industrial Production Index - Mfg. *Base 1970 = 100*



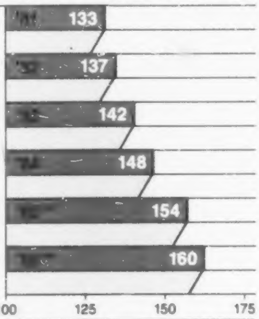
*Total Year **Projections N/A—Not Available
Sources: U.N. Economic Committee for Europe
CMEA Data yearbook 1981
NATO External Economic Relations
Barclays Bank, U.K.
National Westminster Bank
Forecast of Wharton Planned Economies Service

German Democratic Republic (GDR)

Gross Domestic Product (GDP): $150 Billion (1984 Est.)
Exchange Rate U.S. $1 = .39 Mark

	'81	'82	'83	'84	'85**	'86**
Wage Cost-Mfg. *Base 1980 = 100*	N/A	N/A	N/A	N/A	N/A	N/A
Foreign Trade* *Billions U.S. Dollars* **Imports**	5.9	5.0	6.0	7.9	9.7	11.1
Exports	5.4	6.0	5.9	6.6	7.7	8.5
Trade Balance	−0.5	+1.0	−0.1	−1.3	−2.0	−2.6

Industrial Production Index - Mfg. *Base 1970 = 100*



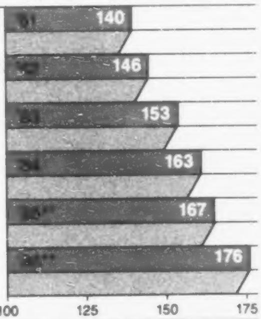
*Total Year **Projections N/A—Not Available
Sources: U.N. Economic Committee for Europe
CMEA Data yearbook 1981
NATO External Economic Relations
Barclays Bank, U.K.
National Westminster Bank
Forecast of Wharton Planned Economies Service

BULGARIA

Gross Domestic Product (GDP): $50.4 Billion (1983 Est.)
Exchange Rate U.S. $1 = 1 Leva

	'81	'82	'83	'84	'85**	'86**
Wage Cost-Mfg. *Base 1980 = 100*	N/A	N/A	N/A	N/A	N/A	N/A
Foreign Trade* *Billions U.S. Dollars*						
Imports	2.1	1.9	1.8	2.3	2.9	3.4
Exports	1.4	1.2	1.0	1.1	1.3	1.4
Trade Balance	−0.7	−0.7	−0.8	−1.2	−1.6	−2.0

Industrial Production Index - Mfg.
Base 1970 = 100



*Total Year (Western Industrial Countries) **Projections

Sources: U.N. Economic Committee for Europe
CMEA Data yearbook 1981
NATO External Economic Relations
Barclays Bank, U.K.
National Westminster Bank
Forecast of Wharton Planned Economies Service

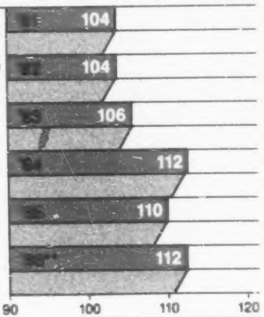
N/A—Not Available

YUGOSLAVIA

Gross Domestic Product (GDP): $122 Billion (1983)
Exchange Rate U.S. $1 = 190 Dinars

	'81	'82	'83	'84	'85	'86**
Wage Cost-Mfg. *Base 1980 = 100*	137	175	223	324	441	N/A
Foreign Trade* *Billions Dinars*						
Imports	45	57	96	156	275	N/A
Exports	32	44	78	133	256	N/A
Trade Balance	−13	−13	−18	−23	−19	N/A

Industrial Production Index - Mfg.
Base 1980 = 100



Source: Organization of Economic & Cultural Development
*Monthly Average
**Projections
N/A—Not Available

cars, electronic steering components and electrical goods.

Investment in 1984 was $8.1 billion representing a 2 pct increase over 1983. The forecast for 1985 is expected to be about the same.

West Germany is Bulgaria's main trading partner. Machinery and equipment account for 48 pct of Bulgaria's total exports. Some 46 pct of its imports are fuels, minerals and metals; 34 pct, machinery and equipment.

To encourage greater Western involvement in Bulgarian trade, the country issued a decree in 1980 permitting joint ventures with western companies.

Trade with the U.S. has centered on agricultural commodities. The best prospects for U.S. exports are products that will help modernize Bulgaria's industrial and agricultural industries. Such products as metal-working machines, computer technology, mining equipment and analytical and scientific equipment are bright spots for U.S. manufacturers.

YUGOSLAVIA

Yugoslavia is positional somewhere between East Europe and the West. It is a communist country which has distanced itself from the USSR and cultivated relations with the capitalist powers. To some extent, it is suffering because of this. Some 47 pct of its $10.2 billion exports in 1984 went to socialist countries, while 45 pct of its $11.9 billion imports orginate in the West. Not only does it have an adverse balance of trade, it also suffers from a shortage of foreign exchange.

By far its most pressing problem, though, is inflation. . .80 pct in the last 12 months, the highest in Europe. According to one Yugoslavian economist, there is little hope of solving this problem until 1990. The question will be, how to get through the next five years.

The leadership says it cannot close factories and displace workers. Nor does it want to resort to Soviet-type price regulation which will stymie supply.

Industrial output increased by 5.5 pct in 1984 and 4 pct is planned for 1985. The first half of 1985, was poor and it is doubtful if the target will be met. Basically, Yugoslavia has a sound industrial infrastructure. A great deal of investment has been made in new machinery over the past two years.

The problem is to find an outlet for Yugoslav products. Much of the capacity is under-utilized. The Yugoslavs have complained about protectionism in their main Western markets and they have approached the EEC with proposals for a new agreement. They want either free access or higher quotas for some 90 key products. These comprise 50 pct of their exports to the EEC.

The country has a flourishing automotive industry and the company, Crvena Zastava is beginning a drive to sell its Yugo 55 in the U.S. market. Yugo has already done surprisingly well in parts of Europe and is regarded as one of the best East European cars. Crvena Zastava estimates that it will sell 10,000 Yugo 55s in the first year, increasing to 150,000 by 1989. The car will sell for less than $4000.

An ambitious plan is for the country to build its own supersonic jet fighter. Other projects include helicopters, missiles, other aircraft and advanced electronic equipment. The Yugoslavian government says it seeks foreign capital in the form of joint ventures rather than loans and credits.

CZECHOSLOVAKIA

The Czechoslovakian economy has been stagnant since 1981. There are signs, however, that investment is beginning to pick up in such areas as machinery, equipment and construction.

Traditionally, Czechoslovakia has been a leader in certain manufacturing areas such as machine tools and turbine generators. But the country is becomming less competitive in the world market due mostly to the government's lack of an effective plan to improve foreign trade.

Czechoslovakia is currently developing its Eighth Five-Year Plan (1986-1990). Various reports indicate that the country will continue to emphasize development of electronics, computers, robotics, pollution control, and energy saving equipment. Industrial production is expected to continue generating about 62 pct of national income.

Czechoslovakia is increasing its export trade with both socialist and non-socialist countries. However, it is reducing imports from non-socialist trading partners.

Trade with the U.S. has fallen since 1980 because of the country's better than average grain harvests. U.S. exports of machinery and other non-agricultural goods fell in 1984 and 1985 due mostly to the high U.S. dollar.

Potential areas of export growth for U.S. manufacturers include technology to improve the country's ailing industrial plants and energy-saving equipment.

HUNGARY

In terms of economic reform, Hungary is Comecon's "pace-setter" with policies aimed at bringing its domestic price structure in line with world market levels.

Hungary's economy is heavily dependent on foreign trade since it lacks raw materials. The government's main concern is conserving energy and increasing agricultural productivity.

Hungary has emphasized a policy of slow growth in order to promote economic adjustment. During 1984, its modest economic targets were realized: national income expanded by 3 pct and the average real income per capita increased by 1 pct. Investments were also down 1 pct. As a result of this adjustment, industrial activity and imports are expected to grow slowly during the next few years.

In the first half of 1985, Hungary recorded a trade deficit, against a 1984 trade surplus of $300 million for the same period. Exports dropped in foodstuffs and metallurgical products. Hungarian aluminum prices dropped by 20 pct and manufactured products dropped 4 to 5 pct. The country had to purchase energy with hard currency to counter the severe winter of 1984-85.

The country's Sixth Five-Year Plan (1981-86) called for a stable economy to maintain the standard of living. Hungary's overall economic development is second only to the GDR. This is a result of a reform program begun in 1968 (The New Economic Mechanism) that resulted in enterprise initiative that produced greater market orientation, greater availability of consumer goods and a higher standard of living.

Regarding trade with the U.S., Hungary is afforded Most Favored Nation tariff treatment stemming from a 1978 bilateral trade agreement. Since 1978, trade between the two countries has increased some 61 pct, from $166 million in 1978 to $268 million in 1983. Principal U.S. exports were animal feed, industrial machinery, agricultural equipment, chemicals and hides. Major Hungarian exports to the U.S. included buses, electrical equipment, metals, shoes and canned hams.

Potential areas of U.S. export growth include technology for agricral production, food processing and energy resource management.

ROMANIA

Romania is just now beginning to emerge from an economic slump that lasted from 1981 to 1983. Although falling short of government expectations, the economy during the past two years is showing a sign of erratic growth.

In 1984 industrial output rose 5.1 pct against a target of 8 pct. Growth in personal income was 3.4 pct against a target of 5 pct. Romania's current Five-Year Plan (1981-85) called for a 7.1 pct annual income growth rate. During the first quarter of 1985, industrial production was down compared to the same 1984 period. But in April industrial production rose 11.6 pct. This "see-saw" phenomena is a result of a severe winter during the early months of 1985. Romania may yet achieve its 7.5 pct growth rate target for 1985.

Romania's economic priorities include developing domestic fuel, energy and raw material resources and increase exports. In addition, the country wants to reduce dependance on foreign sources of supply.

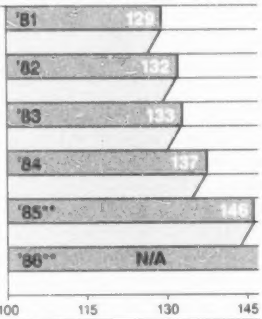
Mechanical engineering, ferrous metals and chemicals account for 55 pct of Romania's industrial production.

CZECHOSLOVAKIA

Gross Domestic Product (GDP): $115 Billion (1984 Est.)
Exchange Rate U.S. $1 = .15 Krone

	'81	'82	'83	'84	'85**	'86**
Wage Cost-Mfg. *Base 1980 = 100*	N/A	N/A	N/A	N/A	N/A	N/A
Foreign Trade* *Billions U.S. Dollars*						
Imports	3.2	2.9	3.0	3.7	4.4	4.9
Exports	2.9	2.8	2.9	3.2	3.7	4.1
Trade Balance	−0.3	−0.1	−0.1	−0.5	−0.7	−0.8

Industrial Production Index - Mfg. *Base 1970 = 100*



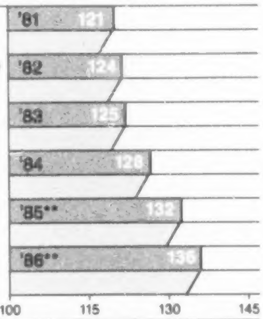
*Total Year (Western Industrial Countries) **Projections
Sources: U.N. Economic Committee for Europe
CMEA Data yearbook 1981
NATO External Economic Relations
Barclays Bank, U.K.
National Westminster Bank
Forecast of Wharton Planned Economies Service
N/A—Not Available

HUNGARY

Gross Domestic Product (GDP): $60 Billion (1984 Est.)
Exchange Rate U.S. $1 = .02 Forint

	'81	'82	'83	'84	'85**	'86**
Wage Cost-Mfg. *Base 1980 = 100*	N/A	N/A	N/A	N/A	N/A	N/A
Foreign Trade* *Billions U.S. Dollars*						
Imports	3.5	3.3	3.2	3.6	4.3	5.0
Exports	2.8	2.8	2.9	3.7	3.8	4.2
Trade Balance	−0.7	−0.5	−0.3	−0.1	−0.5	−0.8

Industrial Production Index - Mfg. *Base 1970 = 100*



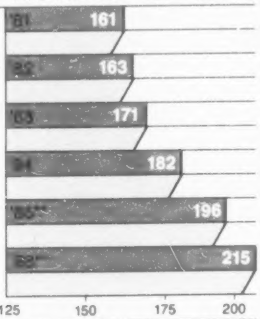
*Total Year **Projections N/A—Not Available
Sources: U.N. Economic Committee for Europe
CMEA Data yearbook 1981
NATO External Economic Relations
Barclays Bank, U.K.
National Westminster Bank
Forecast of Wharton Planned Economies Service

ROMANIA

Gross Domestic Product (GDP): $68 Billion (1983 Est.)
Exchange Rate U.S. $1 = .08 Leu

	'81	'82	'83	'84	'85**	'86**
Wage Cost-Mfg. *Base 1980 = 100*	N/A	N/A	N/A	N/A	N/A	N/A
Foreign Trade* *Billions U.S. Dollars*						
Imports	3.5	1.9	2.0	3.0	4.3	5.0
Exports	3.7	3.4	2.5	2.8	3.2	7.6
Trade Balance	+0.2	+1.4	−0.4	−0.1	−1.0	+2.5

Industrial Production Index - Mfg.
Base 1970 = 100



**Total Year (Western Industrial Countries)   **Projections*
Sources: U.N. Economic Committee for Europe
CMEA Data yearbook 1981
NATO External Economic Relations
Barclays Bank, U.K.
National Westminster Bank
Forecast of Wharton Planned Economies Service
N/A—Not Available

Potential areas of U.S. export growth include agricultural machinery and energy equipment.

POLAND

The Polish economy in the first half of 1985 proved to be depressing.

The country is looking for a quick-return on exports and new export-oriented activities to pay off the $1.6 billion due to Western creditors during 1984-87.

By the end of 1984, Poland's hard currency debt had risen to $27 billion. Liabilities to Comecon lenders amounted to 5 billion Transferable Rubles ($6.6 billion). The year saw the Polish mechanical and electrical engineering sectors failing to meet a planned 30 pct export sales rise to the West. Instead, deliveries of raw materials, primary and intermediate products accounted for the rise in exports.

By mid-1985, industrial production had increased only 2 pct of which manufacturing rose 2.4 pct. The 1985 target is 4 to 4.5 pct.

In 1985 engineering exports to the West also rose 0.6 pct while the rise in imports was 18 pct.

Total exports of mechanical and electrical engineering products, declined by 19.3 pct during the first five months of 1985, compared with the same period in 1984. The 1985 target was an increase of 23.5 pct.

Investments appear to be under better control. Investment is up 5.2 pct in machinery and equipment and down 1.4 pct in new building construction.

New export sectors for Poland are expected to open up following a trade pact signed with the Republic of China. Trade in 1984 was $200 million with China. Poland also signed a $9.2 million barter deal with China in which 1500 "Polonez" cars, trucks, buses and construction vehicles will be sent to China in exchange for cotton and tea.

In the future Poland will be interested in new equipment for its advanced metallurgical and engineering sectors, primary electrical engineering and electronics, coke production, coke-based chemistry products, aluminium and copper processing and its steel industry. Items on the shopping-list include power-electronic drive systems and ac induction motor technology, updated dc motor technology, automation, switchgear, robotics and ways of building up its electronics industry. Poland wants to produce 16-bit microprocessors and 64K memories. In its steel plants, Poland has a need for vacuum-degassing, continuous casting and quality steel production equipment, computers and systems.

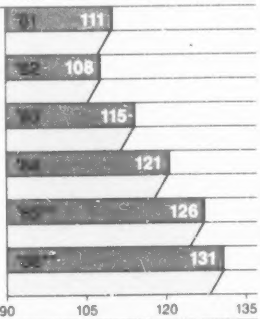
Poland also needs to increase its spending in research and development. It plans to devote 2 pct of its GNP to research by 1986 and 3 pct by 1990. The Polish communist party's central committee believes the country is falling behind its neighbors, technologically. More funds will be made available for imports of scientific equipment and computers. The underlying constraint will be the servicing of its $27 billion debt. Poland's central party committee has asserted that economic growth must be based on productivity gains and improved efficiency.

POLAND

Gross Domestic Product (GDP): $160 Billion (1984 Est.)
Exchange Rate U.S. $1 = .64 Zolty

	'81	'82	'83	'84	'85**	'86**
Wage Cost-Mfg. *Base 1980 = 100*	N/A	N/A	N/A	N/A	N/A	N/A
Foreign Trade* *Billions U.S. Dollars*						
Imports	4.4	3.1	2.8	3.4	4.1	4.6
Exports	3.9	3.6	3.6	4.0	4.7	5.2
Trade Balance	−0.5	+0.5	+0.8	+0.6	+0.6	+0.6

Industrial Production Index - Mfg.
Base 1970 = 100



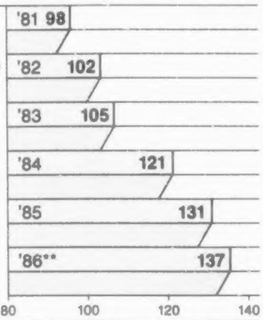
**Total Year (Western Industrial Countries)   **Projections*
Sources: U.N. Economic Committee for Europe
CMEA Data yearbook 1981
NATO External Economic Relations
Barclays Bank, U.K.
National Westminster Bank
Forecast of Wharton Planned Economies Service
N/A—Not Available

DENMARK

Gross Domestic Product (GDP): $63 Billion
Exchange Rate U.S. $1 = 9.5 Danish Kronor

	'81	'82	'83	'84	'85	'86**
Wage Cost-Mfg. *Base 1980 = 100*	109	117	124	130	132	134
Foreign Trade* *Billions Danish Kronor*						
Imports	10.4	11.6	12.4	14.3	16.1	16.9
Exports	9.5	10.5	12.2	13.8	14.7	15.3
Trade Balance	−0.9	−1.1	−0.2	−0.5	−1.4	−1.6

Industrial Production Index - Mfg.
Base 1980 = 100



Source: Organization of Economic & Cultural Development
**Monthly Average*
***Projections*

Scandinavia

Sweden, the country which normally leads a recovery in Scandinavia, will come to an abrupt halt with its gross domestic product likely to post an increase of only 0.5 pct.

DENMARK

Traditionally, Denmark is an agricultural country, but in recent years it has heavily invested in industry. In 1984, for instance, industrial investment jumped by 30-35 pct, the highest rate in 20 years. Industrial output for 1985 was around 5 to 6 pct up over the previous year.

Like other Scandinavian countries, Denmark suffers from wage inflation, with nearly a 40 pct rise over the previous six years. This tends to hamper exports and, indeed, the adverse trade balance is expected to rise slightly in 1986.

The government has a 2 pct guideline in wage increases, but trade union demands are for the introduction of a 35-hour work week with little or no pay loss.

SWEDEN

After three years of good growth, economic activity is expected to come to a standstill next year according to a recent forecast of the Swedish National Institute of Economic Research. The gross domestic product is likely to show an increase of less than 0.5 pct, following rises of 3.3 pct and 2.5 pct respectively in 1984 and 1985.

Inflation at just over 7 pct in 1985 is above the European average. There are expectations that this can be brought under control with a forecast of around 5 pct for 1986.

Persistently high wage increases have served over several years to undermine Sweden's international competitiveness. This is particularly serious because the country lives by exports. Nearly half of the country's engineering output is sold abroad. For 1986, industrial production is expected to rise 5 pct over 1985, slumping as the year progresses.

To combat high manufacturing costs, Sweden has been among the forerunners of advanced automation and has pioneered robotics and automatic assembly. Asea is today the largest robot supplier in Europe and is growing at the phenomenal rate of 50 pct per year. The company is well established in the U.S. market and also is manufacturing robots in Japan.

Sweden's thriving automotive industry and its two carmakers—Volvo and Saab—were both profitable last year. Both rely heavily on sales in the U.S. market.

The outlook is mixed for Sweden. The devaluation of 1982 boosted performance in the two subsequent years. But underlying structural problems remain. Economic growth peaked in 1984 and it looks as if another devaluation could be required to restore stability.

NORWAY

Norway is a major exporter of oil and gas. Over the past few years this has led to large current account surpluses. The country has the same basic problem as Sweden: sharply rising wage costs. This has tended to make manufactured exports uncompetitive, and in recent years there has been a loss of market share abroad.

Inflation continues to fall back in 1984, averaging 6.2 pct against 8.4 pct in 1983. The inflation rate is, however, still higher than the OECD average of 5 pct. The government's target was to achieve 5.7 pct in 1985.

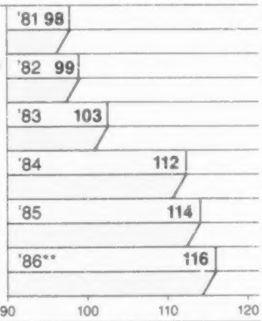
Over the last few years, Norway has deliberately cultivated high technology and moved into the numerical control quite early. Sweden provided a good market for companies like Kongsberg in control systems for advanced manufacturing. The country is making a determined effort to supply the international automotive industry with sophisticated components. The government is providing assistance to a small, but highly active group of companies in this field.

SWEDEN

Gross Domestic Product (GDP): $71 Billion (1985 Est.)
Exchange Rate U.S. $1 = 7.9 Swedish Kronor

	'81	'82	'83	'84	'85	'86**
Wage Cost-Mfg. *Base 1980 = 100*	110	118	127	141	155	162
Foreign Trade* *Billions Kronor*						
Imports	12.1	14.5	16.7	18.2	21.4	25.0
Exports	12.07	14.0	16.7	20.2	21.4	22.6
Trade Balance	0	−0.5	0	−2.0	0	−2.4

Industrial Production Index - Mfg.
Base 1980 = 100



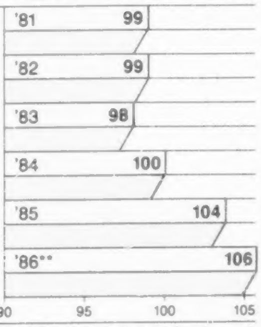
Source: Organization of Economic & Cultural Development
**Monthly Average*
***Projections*

NORWAY

Gross Domestic Product (GDP): $62 Billion (1984)
Exchange Rate U.S. $1 = 7.8 Norwegian Kronor

	'81	'82	'83	'84	'85	'86**
Wage Cost-Mfg. *Base 1980 = 100*	110	121	132	146	150	154
Foreign Trade* *Billions Norwegian Kronor*						
Imports	7.5	8.3	8.2	9.4	10.4	N/A
Exports	8.7	9.4	10.9	12.8	13.4	N/A
Trade Balance	+1.2	+1.1	+2.7	+3.4	+3.3	N/A

Industrial Production Index - Mfg.
Base 1980 = 100



Source: Organization of Economic & Cultural Development
**Monthly Average* *N/A—Not Available*
***Projections*

CAPITAL SPENDING

Why It Will Be Flat This Year

☐ In this PRODUCTION Magazine exclusive survey, manufacturers reveal that their purchases of equipment in 1986 will not be much different from last year.

☐ Major purchases of equipment from offshore suppliers will be evident in 1986 as well as the use and implementation of advanced manufacturing technologies.

By Ed McCallum

BASED ON THE SURVEY CAPITAL EQUIPMENT requests will reach $10.7 billion for 1986. Of that total, respondents expected to obtain approval for $8.43 billion worth of equipment purchases. This figure was being used for all projections.

The spending level, while down from a year ago, would approximate actual spending during 1985.

Our 1986 findings, obtained through our annual survey (this is our 18th) conducted last August and September, checked equipment purchases, and the reasons behind these needs.

Typical plant spending for machinery and equipment is depicted in the chart on the following page.

The survey indicated that plants were operating at 76 pct of capacity in August-September, 1985, down slightly from one year ago. Of the total, 51.8 pct of the respondents plan to operate at higher levels of capacity this year while only 5.4 pct believe operating rates will be at a lower level. And that's the good news. The bad news is that only 41 pct of the respondents expect to have increased capital budgets, compared to 51 pct a year ago; 17.4 pct reported lower budget requests. Add to that, only a third (33.8 pct) of those surveyed report incoming orders up. This is compared to 47 pct last year. These negatives help confirm more moderate investment plans in 1986.

As in past years, most of those surveyed (64.8 pct) continue to zero-in on direct labor as the primary cost reduction target for 1986. This is a difficult position for PRODUCTION Magazine to justify as materials costs, as a percentage of attributed cost, was 50 pct higher than direct labor in the make-up of the manufactured cost. Other cost reduction efforts targeted for improvement are: in-process inventory, 28.8 pct; material costs, 28.4 pct; scrap-rework, 25.8 pct; in-direct labor, 22.7 pct, and perishable tools and supplies, 9.1 pct.

Offshore Suppliers

Of total respondents, 53.8 pct reported the purchase of a portion of equipment needs from offshore suppliers. For these respondents, 40 pct of the total planned investment will be placed offshore and will be used primarily to fund: metalcutting machine purchases, (56.7 pct); metalforming equipment purchases, (14.7 pct) and gaging-inspection-testing equipment, 14.6 pct of the respondents. Reasons given for offshore sourcing: equipment quality (72.9 pct), prices (69.5 pct), availability (38.1 pct) and service (21.3 pct).

First year return-on-investment (pre-tax) requirements remain virtually unchanged at 32 pct, on average. No change over the years still can mean manufacturers are faced with equipment payback periods of 2½-2¾ years.

How Plants are Spending

% Total Investment 1986	Total Projection (Mil $)	% Change 1986 from 1981-1985 Average	Machine/Equipment
38.5	3245*	+ 4.0	Metalcutting
11.4	961	- 21.3	Assembly
11.4	961	+ 40.7	Other
11.2	944**	- 2.7	Metalforming
7.2	606	+ 16.1	Gaging/Inspection/ Testing
6.5	547	- 11.0	Cleaning/Finishing
5.2	438	- 8.7	Material Handling
4.0	337	- 18.4	Weld/riveting/brazing
2.6	219	Same	Plastic Molding
2.0	168	- 16.7	Heat Processing

*$1931 million to sourced domestically

**$642 million to be sourced domestically

Survey Scope: *Plants reached by PRODUCTION Magazine in: Fabricated Metal Products (SIC 34); Machinery, except Electrical (SIC 35); Electrical Machinery (SIC 36); Transportation Equipment (SIC 37); and Instruments (SIC 38). 1986 figures are projected from 2017 respondents from 12,000 plants contacted in keeping with past procedures.*

Plant Employment and Capital Spending

Plant Employment	Machinery/Equipment Expenditures
Less than 50 persons	$ 146,382
50-99 persons	$ 199,951
100-499 persons	$ 480,971
500-999 persons	$1,277,087
1000 or more persons	$4,015,189

Of the total, 36 pct reported having approval equipment budgets as of last August, and 44.9 pct expected approval by year-end with the balance during the first quarter of this year. As a group, the 64 pct that reported they were awaiting approval, estimated they expected to receive only 72 pct of the funds requested. Nine percent of the dollar value of planned-for equipment has already been placed with suppliers.

While investments in metalcutting and metalforming machinery continue to take about 50 pct of investments, advanced manufacturing technologies continue to make inroads and are beginning to successfully compete for investment dollars. You'll note in the investment by type of equipment table on page 66 the $961 million reported in "other" is primarily for system and control investments. Many respondents wrote in that they didn't know where to assign these investments.

Over the next three years, 56.7 pct of the total respondents plan to purchase CNC equipment, up from 52.1 pct one year ago and up 64 pct over the past ten years. In addition, 67.0 pct of you report use of CNC, up from 62.8 pct reported in last year's survey and 59.3 pct two years ago. Of those plants planning CNC equipment purchase, only one plant in eight will be an initial installation; 70.7 pct of the plants employ 100 or more persons (27.2 pct in plant of 500 or more); the 88.5 pct that currently operate CNC equipment operate a median of 4 machines-the range of CNC machines operated ran from 1 to 300; and 65.9 pct of the respondents will spend 42.5 pct of your total capital investments appropriation with offshore suppliers.

Of total respondents, 11.4 pct are planning electrical discharge machine (EDM) purchases over the next three years. This is about the same level of purchase activity as last year and up about 10.5 pct over two years ago. Of the total respondents, 21.8 pct report EDM use with installations spread over 94 industries (standard industrial classifications) with over three-quarters (77.5 pct) of these plants employing 100 or more persons. Of these planning a EDM purchase: 54.8 pct are first time buyers; 41.3 pct will purchase RAM (standard) machines; 63.9 pct will purchase wirecut EDM and slighty more than 10 pct will purchase both types. Major EDM purchase activity is shown in the chart at right.

Use of Advanced Manufacturing Technologies

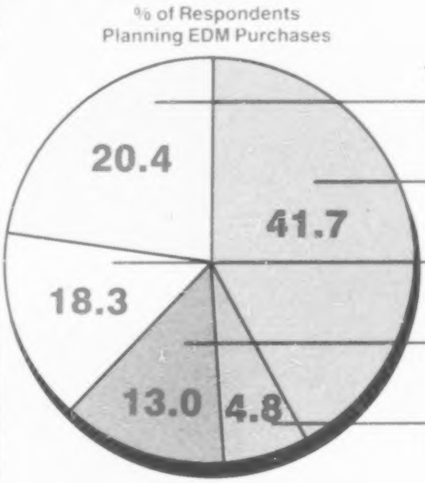
COMPUTERS: Nearly four out of five respondents (79 pct) plan to apply computers and systems in manufacturing operations over the next three years. In fact, some respondents report practically their entire planned investments will be used to initiate or expand their use of computerized data systems in the manufacturing area. And while the computer inroads to help control manufacturing efficiency, cost and quality may appear to have lagged other computer applications in the plant, the fact is that 2.6 times more plants plan computer application over the next three years than did respondent plans reported in our survey of five years ago.

Of those surveyed 56.9 pct of those planning to install or expand the use of computers in manufacturing are located in plants employing 50-500 and only 16.6 pct in plants of less than 50 employees.

MANUFACTURING CELLS: 19.3 pct are planning to purchase cells by 1988. (A manufacturing cell was defined in the survey as comprising one materials handling device servicing multiple machines, coordinated and paced by a computer or programmable controller). Of these, 40.1 pct (250 plants) report they currently operate cells, 92.9 pct of these planning use are located in plants employing 100 or more—over half in plants employing 500 or more. Typically, the plants planning cell purchase will spend $1-million (median) on production equipment; 21.6 pct of these plants will spend between $2 million to $50 million in 1986.

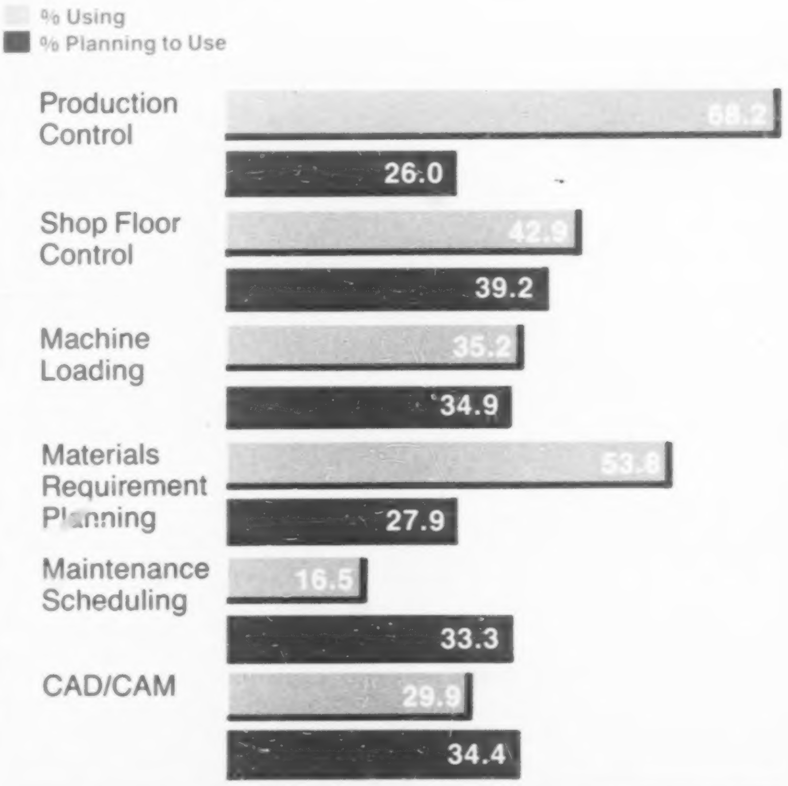
FLEXIBLE MANUFACTURING SYSTEMS: 15.6 pct plan to purchase FMS over the next three years. Like cells, purchase plans tend to be concen-

EDM Purchases by SIC



Industry	SIC
Fabricated Metal Products	34
Machinery, except Electrical	35
Electrical Machinery	36
Transportation Equipment	37
Instruments	38

Computerized Data Systems Usage



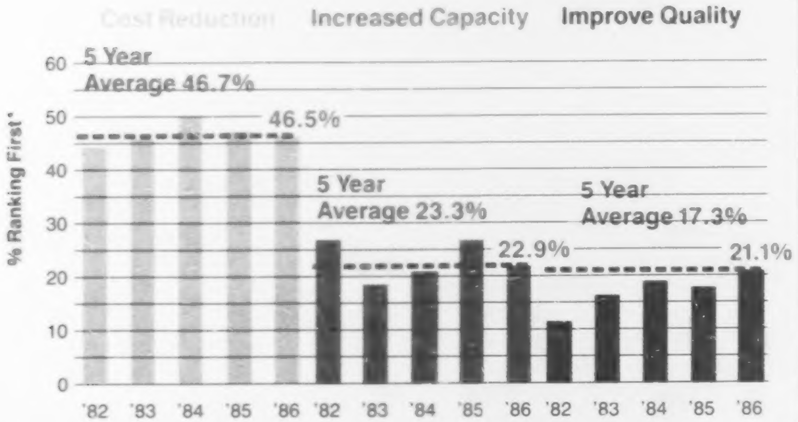
Robotics and How They Will be Used

Robot Applications	Currently Use	Plan to Use
Arc Welding	11.9%	25.2%
Spot Welding	6.0%	10.2%
Assembly	16.8%	35.8%
Machine Load/Unload	27.2%	51.9%
Material Handling	12.2%	30.4%
Spray Painting	9.3%	20.0%
Other	3.6%	3.3%

Base: Respondents planning robot purchases 1986-88.

The Reasons Behind Equipment Purchases

(TOTAL RESPONDENTS 1982-1986)



**Some respondents ranked more than one motive first.*
Source: PRODUCTION'S Capital Spending Survey 1982-1986.

Cost reduction continues as the primary motive to buy equipment. Capacity as a primary motive has decreased in importance reflecting the current flat utilization rates in discrete parts manufacturing. Quality improvement has jumped substantially and is ranked almost as important as increased capacity. Other motives, not grouped include: new products/models—13.1 percent ranking first; more machine/process flexibility—8.7 percent ranking first; more make—less buy—5.8 percent ranking first; followed by energy reduction—ranked first by only 2.8 percent of the respondents reflecting the current availability of energy.

trated in larger plants with 91.2 pct of these planning FMS purchase located in plants employing 100 or more, and 51.7 pct in plants with 500 or more persons. (An FMS was defined in the survey as comprising multiple material handling devices servicing multiple machines with a computer responsible for coordinating, pacing and scheduling). Based on this definition, 91 plants report they currently operate FMS of one type or another (metalcutting, metalforming, assembly, etc.); 14.6 pct (46) of the plants planning purchases intend to spend $5 million or more on manufacturing equipment in 1986. As a group, these 46 plants intend to spend $582.2 million this year.

LASERS: Lasers continue to capture attention and capital dollars as 15 pct reported plans to include their purchase 1986-88. Laser purchase intentions, while a little lower than reported last year, continue to cause a significant shift in investment from the more traditional production equipment purchase pattern. Lasers will be purchased for cutting operations (38.4 pct of these planning purchase), for welding (21.2 pct), drilling (16.2 pct), and heat processing (4.6 pct). Gaging and measuring laser use will account for the largest share with 42.7 pct of these respondents reporting planned purchase activity.

ROBOTICS: Better than a third of all of the respondents are planning robotic purchase within the next three years. Most of those that plan robotic purchase over that period (88 pct) are located in plants employing 100 or more persons. Industries which continue to be heavily committed to robotic usage and investment include: Fabricated structural steel products (SIC 344), forgings and stampings (SIC 346), fabricated metal products (SIC 349 with heavy activity in valves and pipe fittings), construction mining, oil field and material handling (SIC 353) metalworking machinery and equipment-both as users and OEMs (SIC 354), general industrial machinery (SIC 356), electronics components and accessories (SIC 367), electrical lighting and wiring devices (364) motor vehicles, motor vehicle parts (SIC 371) and measuring and controlling instruments (SIC 382). **P**

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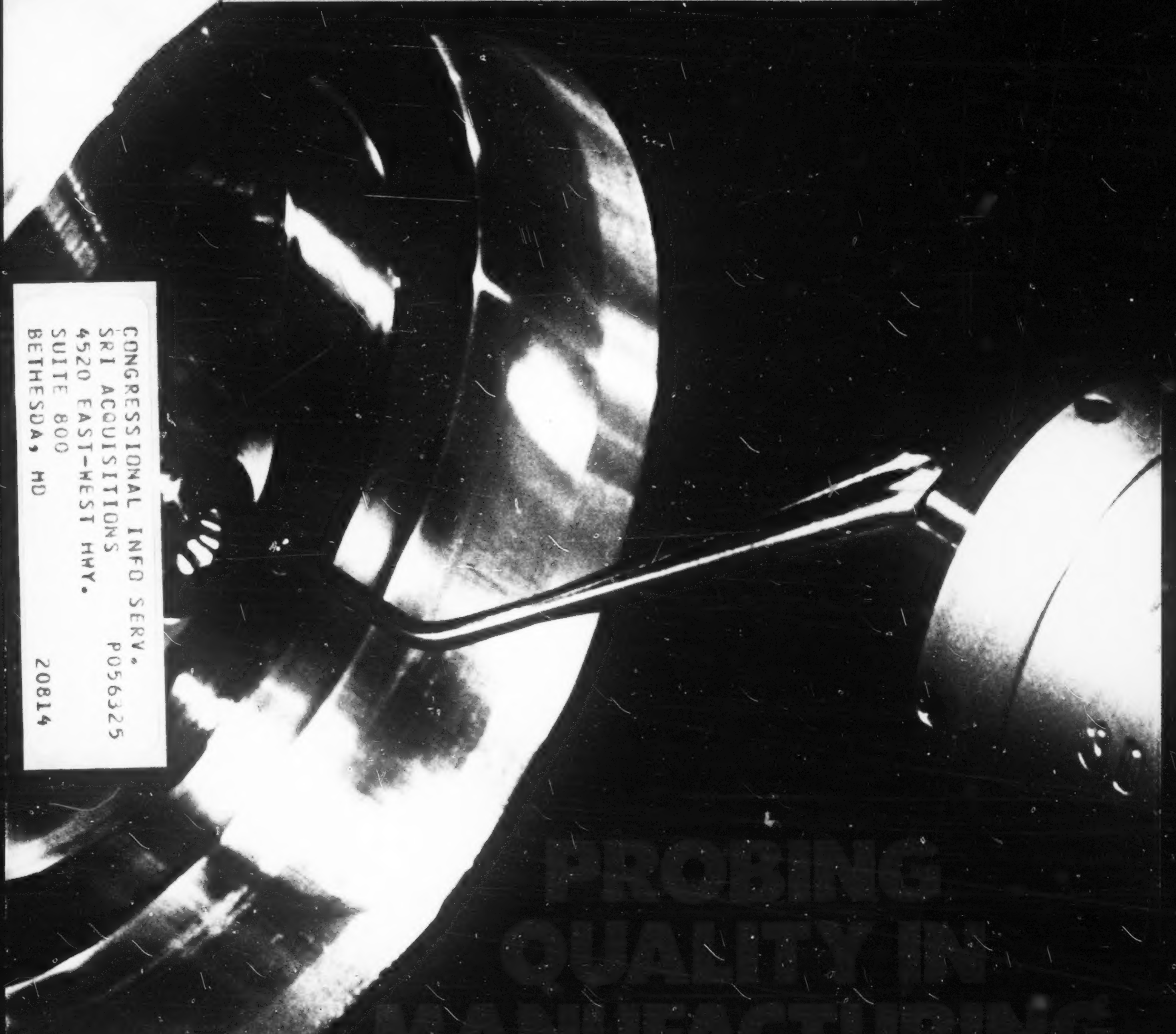
FEBRUARY 1986

PRODUCTION

FOR MANAGERS OF MANUFACTURING TECHNOLOGY



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PROBING QUALITY IN MANUFACTURING

Machines That Talk Are Making Noises in the Factory

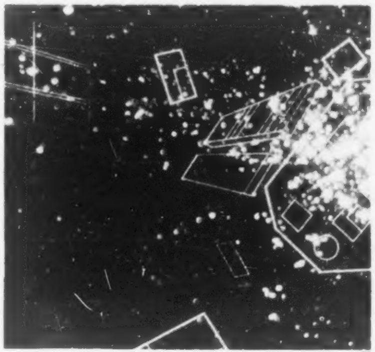
Automated Welding Trickles Down to the Small Shop

Special Technical Reports from Two Conferences

PRODUCTION

FEBRUARY 1986
VOL. 97 NO. 2

COVER-TO-COVER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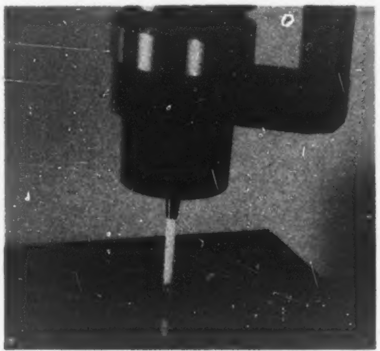
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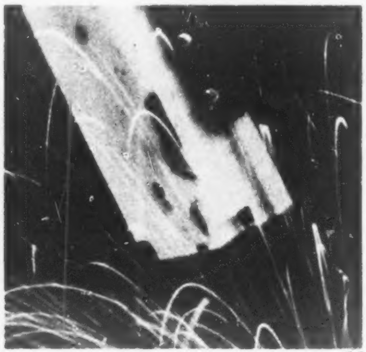
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FEATURES

PROBING QUALITY IN MANUFACTURING

30 *Quality Control is now viewed as a cost reduction tool, rather than the traditional acid test for product acceptability. Probes, sensors, lasers and CIM ultimately will result in higher productivity.*

VOICE TECHNOLOGY IS BEGINNING TO SPEAK UP

40 *The development of computers that can actually talk is well on its way to becoming a multibillion industry by the year 2000. The implications for business and industry will be staggering.*

AUTOMATED WELDING EQUIPMENT TRICKLES DOWN TO THE SMALL SHOP

46 *Manufacturers are now targeting high tech welding technology to the small shop, offering price, productivity, payback—and quality.*

PUSHING BACK THE FRONTIERS OF MANUFACTURING

55 *PRODUCTION Magazine spotlights recent developments and applications of new manufacturing equipment excerpted from two machine tool forums held in the United States and West Germany.*

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An Active Labor Year Seen in '86

Labor contracts covering 3.8 million workers expire or will be re-opened for negotiation this year, with major agreements to be negotiated in the construction, steel and farm machinery industries, the Bureau of Labor Statistics reports.

The total represents 41 pct of the 9.1 million U.S. workers covered under collective bargaining agreements for 1,000 employees or more.

Among the contracts open next year are agreements between the United Automobile Workers and Caterpillar Tractor and Deere & Co. Agreements between United States Steel and other major producers and the United Steelworkers of America expire in August, 1986.

By contrast, the percent of companies with expansion plans for their office/clerical and technical/professional staffs was steady, with fourth quarter and first quarter projections at 13 pct and 11 pct respectively. Projections of expansion in the office/clerical and technical/professional sectors have been fairly stable over a period of almost two years.

Layoffs remain considerably higher among production/service employees than in other employment sectors, BNA reported.

Thirty pct of the companies reported having production/service workers on layoff in October and November, up from 27 pct in July and August and five pct points higher than for the same period in 1984. The increase in production/service layoff incidence is greatest among southern and north-central organizations.

Fifteen percent of the firms responding to the survey expect reductions in their production/service workforces during the first quarter of 1986, up three percentage points from the previous quarter. The proportion of firms anticipating workforce cutbacks increased in all regions but the south.

–Ed Bowers

WASHINGTON

Machine Tool Orders Fall 19 Pct in November to $186 Million

Reflecting the continuing slump of the U.S. manufacturing industries, new orders for machine tools in November totalled just over $186 million, down 19 pct from October's order level.

According to the National Machine Tool Builders' Association (NMTBA) cumulative orders for the first 11 months of 1985 totalled $2.34 billion, a level 12 pct below the value of orders received during the same period last year.

The NMTBA reported that November machine tool shipments stood at $197 million, down 1 pct from October, and left the year-to-year total at $2.17 billion, an increase of 8 pct over the 1984 11 month total.

NMTBA President, James A. Gray, remarked that the while the overall economy is beginning to show signs of rekindled growth, the manufacturing sector is still struggling. "The continued slump in machine tool orders reflects the current status of American's manufacturing industries," Mr. Gray said. "Adding to the problem," he continued, "is concern over the fate of tax reform. As things currently stand, Congress is poised to take back the very elements that led to the capital spending boom of the early 1980s."

"It's not tax reform, it's tax redistribution," asserted Mr. Gray. "It's incredible that considering the United States' huge trade imbalance, the new tax bill provisions discourage investments in new equipment."

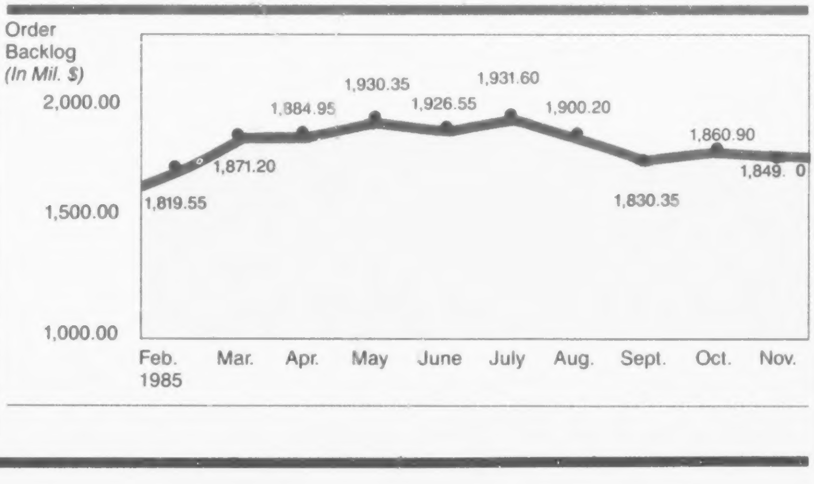
The NMTBA also reported that metalforming orders for November totalled only $14.6 million—about 80 pct below October's figures. Metalforming shipments, at $59.8 million, were down 13.9 pct from their October total. Orders for metalcutting machine tools, at $171.6 million, increased 10 pct in November, while shipments of $137.7 million were up 6 pct from October.

Machine tool order backlogs decreased in November, to $1.85 billion, from $1.86 billion in October.

–Ed Bower

MACHINE TOOL ORDERS

Backlog



tained we can get the real operating time of the systems in one month longer then 500 hours. Main causes of system breakdown come from operator's error (60 pct) and engineering mistakes (20 pct), while 15 pct of occurrence of the system breakdown comes from tool breakage in use.

Developments

There are several recent drastic progresses in the field. One is the success of the weekend operation of the systems for machining the press forming dies. The second progress is new development of the simulation program for design and operation verification of the flexible manufacturing system. The third one is real time scheduling for operation of the flexible manufacturing system. One machine tool builder has developed a special operating algorithm with which the central computer can decide the following event after finishing one operation by computing the priority of all the remained events. This gives the operation of the system high flexibility and increases utilization of every hardware component such as machine tools, tools, pallets, jigs and fixtures. The fourth progress can be seen in development of transfer type flexible manufacturing systems which can be applied to the medium lot size and medium volume production. The similar, five or six different kinds of mechanical parts are machined in sequence with the cycle time from two to five minutes in the flexible transfer line consisting of more than ten NC machine tools. Because of more frequent use, 60 pct of the system breakdown is found to come from poor design, assembling and adjustment of the machine tools and the associated mechanical devices. So it is desired that every mechanical part in the system must be more carefully designed and assembled.

Trends in CIM in the USA

Paul R. Warndorf, *Cincinnati Milacron Inc.*
M. Eugene Merchant, *Metcut Research Associates, Inc.*

The integration of data, information, and control of product, from the concepted stage through production, to shipment and support, is referred to as Computer-Integrated Manufacturing (CIM). Though no company has yet achieved total integration of its operating environment, great strides are being made in the CIM direction. To many manufacturers, this will be the operating mode of the "Factory of the Future" and is the only solution to survival for the manufacturing industry.

In recent study conducted by the CAD/CAM Interface Committee of the Manufacturing Studies Board of the National Research Council, five of the leading U.S. companies in the development of CIM were reviewed to determine the expected benefits of CIM. Those are shown in the accompanying table.

The Board also stated that the problems associated with integration today occur at three levels:

1. The ability of different programs to communicate together even on the same computer.
2. Communication problems which exist between computers even of the same brand.
3. Communication problems among a variety of manufacturers' systems.

The Board also points out the importance of continuing work on resolving these problems and the importance of standardization to CIM.

A key to the success in overcoming the above problems in the United States is through programs and investigations into common standards like the Initial Graphics Exchange Specifications (IGES), a program initiated and funded by the U.S. Air Force. Two other important U.S. programs addressing the problem of computer integration are MAP and AMRF. MAP is a proposed technical standard specification for a Manufacturing Automation Protocol in the manufacturing Local Area Network environment. It was originated by the advanced product and manufacturing staff of the General Motors Technical Center. The standard is now gaining wide support. It now involves over 100 American manufacturing companies, and will be tested by the U.S. National Bureau of Standards Automated Manufacturing Research Facility (AMRF).

AMRF, is a test facility which assists in the evaluation and development of proposed standards for integrating the various elements of the CIM system, including both the hardware and software of automated equipment and control systems.

CIM Benefits

Reduction in engineering design cost	15-30%
Reduction in overall lead time	30-60%
Increased product quality as measured by yield of acceptable product	2-5 Times Previous Level
Increased capability of engineers as measured by extent and depth of analysis in same or less time than previously	3-35 Times
Increased productivity of production operations (complete assembles)	40-70%
Increased productivity (operating times) of capital equipment	2-3 Times
Reduction of work in process	30-60%
Reduction of personnel costs	5-20%

CIM is becoming increasingly important in the U.S. as a result of the foreign competitive pressure of cost, delivery and reliability that have, in some cases, outweighed the advantages of product differentiation in the promotion of sales.

Some changes in industry's thinking are taking place and can be seen in various trends in manufacturing operations.

Trends

The first trend originates on the production shop floor. Until now, companies classified themselves as either a producer of goods to order, or a producer of goods for stock. This is the distinction between a job shop and a mass production or process type operation. As a result of the need to meet changing requirements and shorter production cycles, this distinction is being broadened to include a third classification.

Both mid-and high-volume manufacturers, to meet customer pressures, are trying to take on the appearance of suppliers of custom made products while maintaining high throughput of workpieces and optimum use of assets. This is exemplified by the incorporation of tool changing machining center modules into transfer line systems to permit flexibility for part changeovers. It is also apparent in the automotive industry which looks toward custom order manufacturing using flexible manufacturing cells and flexible manufacturing systems as the solution to the problems of short life cycle of parts and fluctuation of demands in delivering components.

A second area of trends deals with plant computer architectures for automated operations. In the factory, local area networks are being designed and used to distribute information between higher level computers and miscellaneous processing equipment. This is preferred over directly connecting the two together, because it permits the easier addition and deletion of components from the network. Micro computers are seen as the lower level controllers to interface computer numerical controls, programmable logic controllers or other control devices to the local area network system. Higher level computers are moving from 16-bit to 32-bit computers. This increases the processing capabiltiy at this higher level.

The third trend is the reevaluation of data base structures for the storing and retrieving of information. This is an important area a company must consider. It is the foundation on which CIM will be built and therefore, it must offer the flexibility to add, delete, and modify current or evolving new features and components without extensive modifications to existing structures. Because of the need for flexibility, there is a move toward relational data base structures. This also seems to be desired because it better accommodates data flow to a variety of users.

Recent Developments in Flexible Manufacturing Systems in Japan

Prof. Dr. K. Iwata, Kobe University, Kobe, Japan

The developments of FMS in Japan were realized at the beginning in the field of machining for mid-volume mid-variety production. As the systems for machining were highly developed later, the developments were expanded in four directions.

The first direction is expansion to the fields other than machining, those are manufacturing utilizing plastic forming, manufacturing of raw materials and unconventional machining, etc. The major interests at present are concentrated to developments of FMS using plastic forming, such as for sheet metal and forging.

The second is dedicated to development of small size or compact FMS which is generally called FMC (Flexible Manufacturing Cell). As regards

Examples of Flexible Assembly Systems developed in 1983

Company where system is installed	Kinds of products	Outline of System		Year of start of operation
		Assembly equipment	Equipment of transportation	
Takasaki Plant of Oki Electric Co.	Chinese character printer 3 types, 143 kinds, number of parts 219, 2000/month	Assembly robot 49, (6 axis robot 21 4 axis robot 28) special purpose unit 21	Automatic cart 4, free flow conveyor	Nov. 1983
Richo Co.	Developing machine 4 kinds	6 axis robot 7	Motorized conveyor, unattached cart and forklift are used partially	Spring 1984
Awazu Plant of Komatsu Ltd.	Parts of construction machinery, mainly arm and frame etc. about 30 kinds	Arc welding robot 7 (rectangular type), versatile stocker 10, complex NC machine 1	Guided unattached cart 3	March 1984
Kaji Plant of Mitsubishi Electric Co.	Electromagnetic switch, 7 kinds number of parts about 30	Assembly robot 4, (4 axis) automatic product inspection machine 1	Free flow conveyor	Oct. 1983
Okazaki plant of Toyoda Machine Works Co.	Vane pump for automobile power steering 24 kinds, number of parts 35	Assembly robot 15 (5 types), measurement, inspection	Linear motor	April 1983
	Flow control valve 6 kinds	Assembly center (assembly robot 3 base frame)	Robot	April 1983

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PRODUCTION

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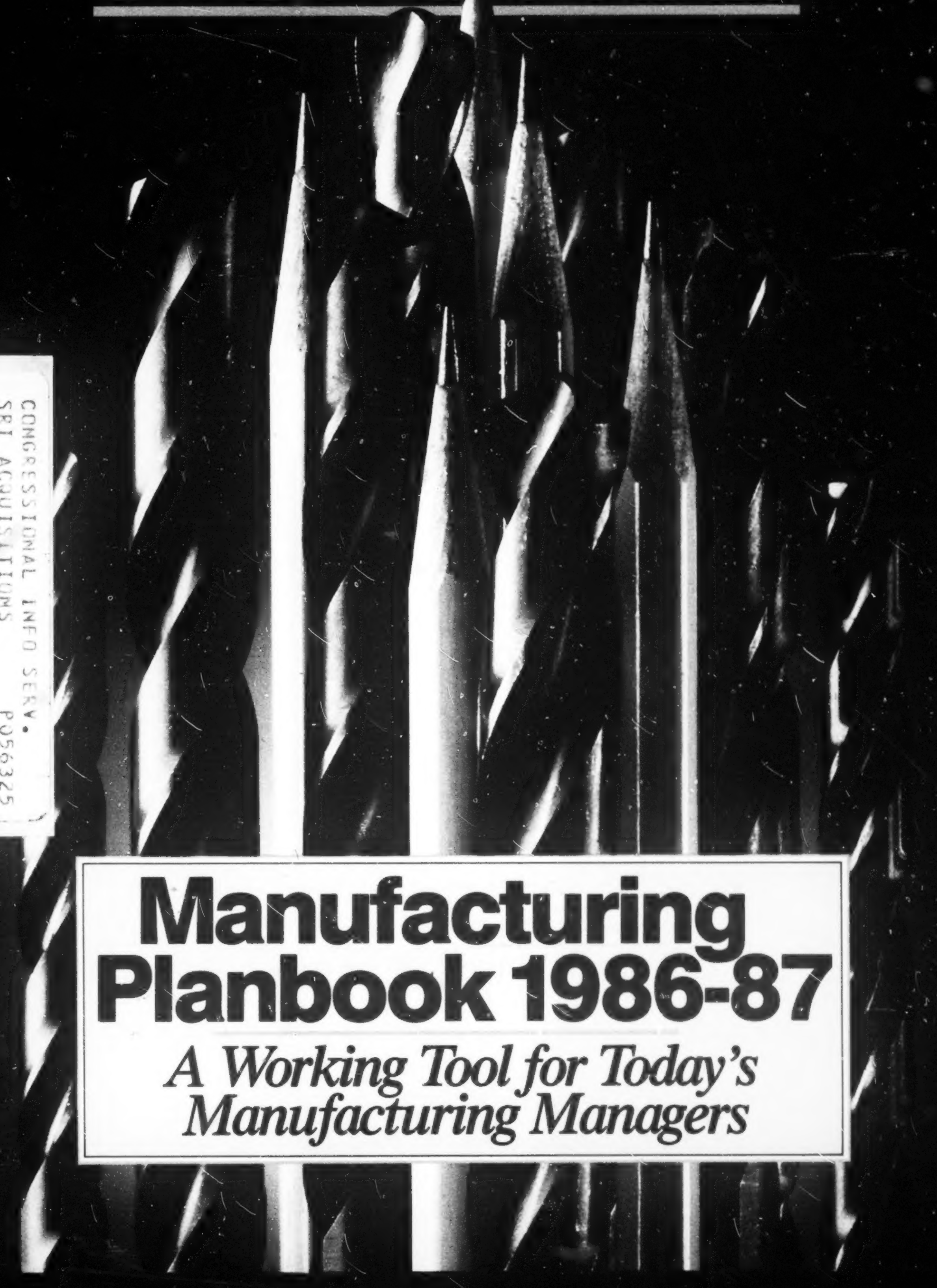

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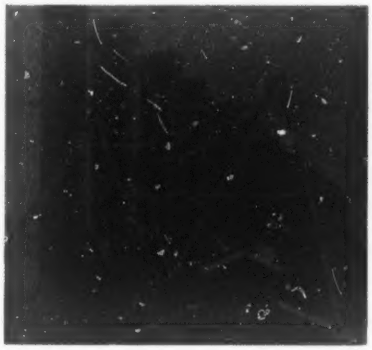

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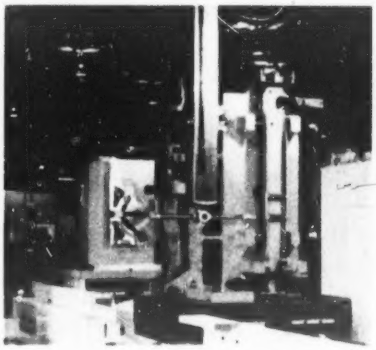

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lines at overseas plants.

–Tools, Dies, Jigs, Fixtures and Contract Machining: Orders and shipments expected to fall as rising imports, the strong dollar and high interest rates continue to cloud the short-term outlook for this industry. Product shipments of tools, dies, jigs and fixtures expected to decrease 3.1 pct after adjustment for inflation.

–Foundry Equipment: Shipments expected to register their second decline in as many years. In real terms, shipments are expected to decline by as much as 6 pct.

–Industrial Heating Equipment: A modest gain in production of the products assuming that user industries—aerospace, electronic, and fabricated metal products—continue to make large capital expenditures for modernization. Shipments and new orders are expected to increase albeit at a slower pace than last year. Industry shipments of industrial heating equipment are projected to rise in constant 1982 dollars, slightly more than 9 pct.

–Power Transformers: The U.S. industry is in serious trouble and is struggling for survival. Transformer industry shipments this year are expected to remain about the same as in 1985. No recovery for producers of large power transformers is expected.

–Motors and Generators: Shipments are expected to show a favorable constant-dollar growth rate this year. Demand for construction and business fixed investment should provide enough stimulus to enable shipments of the motor and generator industry to register a 3 pct rise.

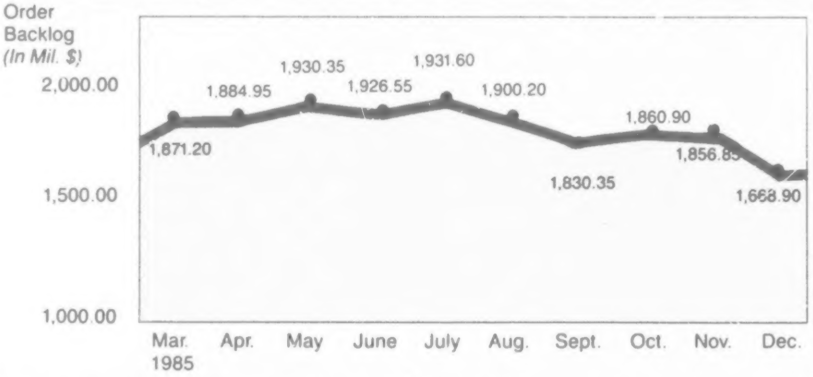
–Industrial Controls: With industrial investment expected to increase, demand should be stimulated resulting in constant-dollar shipments increases at about 4.2 pct more than 1985.

–Autos: Sales are expected to be strong this year, reaching 10.7 million units, slightly above estimated 1985 sales. Domestic car sales are projected to be about 7.5 million units. Import penetration is expected to rise to 29.9 pct this year from 26.4 pct last.

–Railroad Equipment: Shipments, measured in 1982 dollars, should be more than 19 pct higher than last year. Retirement of older equipment coupled with production of new and more efficient cars and locomotives will stimulate purchases by the railroads. Car production is forecast to be 14,500 units while locomotive production should increase to 900.

Machine Tool Picture Mixed In 1985

MACHINE TOOL ORDERS
Backlog



The bottom line was mixed for the machine tool industry in 1985.

Last year's machine tool shipments were up 10.9 pct, but new orders were down 13.2 pct, compared to 1984, according to provisional year-end figures by the National Machine Tool Builders Association (NMTBA).

Machine tool shipments during 1985 totaled $2.54 billion, up from the 1984 final total of $2.29 billion. These results included a rise of 7.8 pct in metal cutting machine tool shipments in 1985, up from $1.61 billion in 1984 to $1.73 billion in 1985. Metal forming machine tool shipments also gained in 1985, up from 1984's $679 million to $804 million.

Machine tool orders totaled $2.53 billion during 1985, down from the 1984 year-end total of $2.92 billion. These figures included a decline of 3.2 pct in new metal cutting machine tool orders in 1985, from $1.92 billion in 1984 to $1.85 billion in 1985. There was also a drop in new metal forming machine tool orders last year, from $1 billion in 1984 to $676 million in 1985.

The one-month change from November to December during 1985 showed an 83.3 pct increase in shipments, from $199 million to $365 million. The increase is attributed to the normal year-end accelerated clearance of shipments.

The November/December comparison in new machine tool orders showed a decline of 9.3 pct, from $195 million to $177 million. The industry's order backlog declined from $1.86 billion in November to $1.67 billion in December.

Commenting on the year-end figures, NMTBA President, James A. Gray said: "This regrettable decline in orders for the year reflects the uncertainity of machine tool buyers in light of President Reagan's anti-growth, anti-business tax 'reform' efforts. We are concerned that these tax proposals, the four-year-old recovery, and forecasts of even lower capital spending this year foreshadow continued order decline."

"We lost money in 1984. We will make money in 1985. We will make more money in 1986," he said.

During the past three years, the company's net profits before taxes has increased 200 to 300 pct, Ikari added. His goal for 1986 is to aim for a 30 pct gross profit and a 10 pct net profit.

Mr. Ikari also said U.S. Amada is attempting to perform additional assembly work in California. "We plan to increase production and assembly here," he said. "Our plant is trying to increase the amount of so-called added value work."

He estimated that sales are approaching $10 million per month, with about $4 million worth of equipment assembled domestically. The cost of assembling the equipment in the U.S. is approximately the same as it is in Japan, he added.

Mr. Ikari said Amada's increasing sales, including those in the U.S., have now made the firm the world's largest manufacturer of industrial machine tools.

U.S. Amada also has been attempting to sell American-made machine tools in Japan, including several manufactured by Bridgeport. But the effort has been difficult, Mr. Ikari said because American machines are improperly configured for Japanese operators.

Mr. Ikari said U.S. Amada will expand its sales force on both the east and west coasts to expand the customer base beyond the job shop environment which currently constitues approximately 60 pct of sales.

"We are setting up for a larger company," he said, noting that U.S. Amada began its domestic operations from a smaller "job shop base."

The West Coast show plaza, which was opened in 1982 at a cost of $12 million, spans 100,000 sq. ft. It includes a training center, theater, atrium and 50,000 sq. ft. showroom where the machinery is displayed. There is also a golf course and restaurant.

Potential customers from throughout the country are flown to the facility, which is patterned after Amada's Machine Tool Plaza in Ishhara City, Japan.
—Reported by Al Senia/Los Angeles

EAST

Job Injuries Down; Costs Up

Although the number of disabling injuries to American workers has decreased 24 pct during the past 10 years, the cost of those injuries has tripled, according to a study from the DuPont Company.

Some 2.5 million disabling injuries were reported in 1973 at a cost of $14 billion, which averages out to $5,600 per injury. By 1982, improved safety management helped cut the number of disabling industrial injuries to 1.9 million, but costs skyrocketed to $31.4 billion. The average cost per incident that year was approximately $16,000. In 1983, the same 1.9 million injuries cost $33.4 billion for an average of $17,500, the study pointed out.

Obviously the ever-increasing costs of insurance and medical care are the two most important factors contributing to the rising price tag pertaining to workers' injuries.

Although the number of manufacturing accidents resulting in injury and death continues to decline, increasing costs in medical care and insurance will continue to spur management to intensify its efforts to enhance the safety of machinery and the overall plant environment.

The National Safety Council reported that manufacturing worker fatalities and injuries have steadily decreased from 1980 to 1985. In 1980, out of a total of 19 million manufacturing workers, there were 1,600 fatalities and 450,000 injuries reported. In 1984, there were only 1,100 fatalities and 300,000 injuries out of the 19 million manufacturing workforce.

In a related development, the safety director for GTE-Valeron Corp. has been sentenced to three months in jail and fined $10,000 for lying to an OSHA inspector during an inspection of the company's tungsten carbide tool manufacturing facility in Syracuse, NY.

The fine and sentence is believed to be the first for this type of offense. Under the Occupational Safety and Health Act of 1970, anyone who "knowingly makes a false statement, representation or certification" to OSHA is liable for a fine of up to $10,000 and/or up to six months in jail.

According to OSHA, the safety director informed an inspector that a "rough cut saw" used to grind tools was down for repairs. In fact, the saw had been disabled at his direction to prevent the OSHA compliance officer from obtaining an accurate reading on worker exposure to cobolt and other dust emitted during machine operation, OSHA said.

The safety director pled guilty in his trial before the U.S. District Court for the Northern District of New York.
–Reported by
Tom Halligan/Philadelphia

MANUFACTURING INJURIES AND FATALITIES

	Workers	Injuries	Fatalities
1980	19 million	450,000	1,600
1981	20 million	400,000	1,400
1982	19 million	290,000	1,000
1983	19 million	330,000	1,200
1984	19.9 million	300,000	1,100

Source: National Safety Council

What You Need To Know About Capital Spending In 1986

An outlook which allows you to:

Note changing trends and objectives in machinery/equipment purchase and use.

Compare your machinery/equipment investment with others in your industry.

By Edward D. McCallum Jr.
Market Research Consultant

In the fall of 1985, the Research Division of Production Publishing Co. surveyed the 1986 spending plans for machinery/equipment in the metalworking market*. Findings indicate how funds will be invested and reasons for spending. Data are provided in charts and tables which will permit you to determine your plant's competitive manufacturing capability in terms of other plants in your specific industry as well as metalworking manufacturing plants generally.

Spending Plans Remain Flat . . .

Respondents to this year's survey are planning to request $10.7 billion for machinery/equipment and investment. They also report, however, they expect to receive approval for only $8.4 billion. This estimate is used for all projections. Respondents plan to apportion their investments for machinery and equipment as listed in Table A.

Numerical Control

Numerically controlled stand-alone machines will continue to capture a large share capital investment in the next three years according to the survey. Of the total, 56.7 pct of the respondents plan purchase over the next three years and about two of three respondents report use of CNC equipment. Of the total 65.9 pct of the plants planning CNC equipment purchase will spend 42.5 pct of their total capital funds with offshore sources with a majority of these investments directed to turning machines, machining centers and punching machines.

Table B indicates the types of CNC machines respondents plan to purchase over the next three years.

Over 50 pct of all CNC purchase activity is accounted for by a small number of industries. Table C illustrates industries that are most active in the purchase of different CNC equipment.

Offshore Sourcing

Of the total respondents 58.3 pct report they will purchase 40 pct of their 1986 capital equipment requirements from offshore sources. Of these respondents: 56.7 pct plan offshore metalcutting machine purchases; 14.7 pct plan metalforming purchases; 14.6 pct plan gaging-inspection-testing equipment purchases; and 24.8 pct other equipment purchases including assembly equipment, joining equip-

Table A

How Plants are Spending

Machine/Equipment	Pct Total Investment 1986	Total Projection (Mil$)	Pct Change 1986 from 1981-1985 Average
Metalcutting	**38.5**	3245*	+ 4.0
Assembly	**11.4**	961	−21.3
Other	**11.4**	961	+40.7
Metalforming	**11.2**	944**	− 2.7
Gaging/Inspection/Testing	**7.2**	606	+16.1
Cleaning/Finishing	**6.5**	547	−11.0
Material Handling	**5.2**	438	− 8.7
Weld/riveting/brazing	**4.0**	337	−18.4
Plastic Molding	**2.6**	219	Same
Heat Processing	**2.0**	168	−16.7

*$1931 million to be sourced domestically
**$642 million to be sourced domestically

***Survey scope:** *Plants reached by PRODUCTION Magazine in Fabricated Metal Products (SIC 34); Machinery, except Electrical (SIC 35); Electrical Machinery (SIC 36); Transportation Equipment (SIC 37); Instruments (SIC 38) and selected portions of Furniture-metal (SIC 25) in plants employing 20 or more persons. 1986 figures are projected from 2,017 respondents from 12,000 plants contacted in keeping with past procedures. See January, 1986 issue of PRODUCTION Magazine for other capital spending details not included in this presentation.*

Table B

Percent of Respondents Planning CNC Purchase

Equipment Type	1986*	1986**	1986-88*	1986-88***
Machining Center-Horiz.-Y axis -27"	10.7	18.8	14.1	24.8
Machining Center-Horiz.-Y axis +27"	6.5	11.4	10.8	19.1
Machining Center-Vert-Y axis −20"	9.0	15.9	12.6	22.2
Machining Center-Vert-Y axis +20"	6.5	11.4	10.3	18.2
Turning Horiz.-Less than 13" chuck	15.7	27.7	20.7	36.4
Turning Horiz.-More than 13" chuck	5.5	9.6	8.9	15.6
Turning Vert-Less than 30" dia table	2.1	3.6	2.7	4.8
Turning Vert-More than 30" dia table	1.7	2.9	3.0	5.2
Boring	4.3	7.5	6.1	10.8
Drilling	5.9	10.4	8.5	14.9
Grinding	8.3	14.6	12.0	21.2
Milling	7.1	12.5	11.0	19.3
Punching	4.3	7.5	7.2	12.7

*Base: 2,017-Total Respondents
**Base: 1,144-Respondents Planning CNC Purchase
***Base: 1,144-Respondents Planning CNC Purchases

ment, plastic molding and heat processing equipment. Industries planning major investment with offshore sources are listed in Table D.

Lasers

Lasers appear to be more readily applied in larger plants, 86.1 pct of those respondents planning purchase are located in plants employing 100 or more persons; almost half (47.7 pct) in plants employing 500 or more. About half of the respondents planning laser purchase over the next three years indicated laser type. Of these: 49.6 pct plan CO2 purchase, 40.3 pct plan YAG and 36.2 pct plan helium-neon powered lasers. Major laser purchase activity is centered in the following industry groups; individual industries (SICs) showing important activity are indicated in Table E.

Cells and Systems

Cell and system usage, as reported by respondents, continues to grow, albeit slowly. Approximately 50 pct of the respondents that reported use of cells and/or systems (FMS) are located in a half dozen industries (SICs). The

Table C

Major Purchases of CNC Equipment by Type

Equipment Type	Most Active Purchasing Industries 1986-88
Machining centers, Horiz., less than 27" Y axis	51.4 pct of respondents planning purchase are located in: Miscellaneous fabricated metal products (SIC 349), metalworking machinery and equipment (SIC 354), general industries machinery (SIC 356), miscellaneous machinery, electrical (SIC 359), aircraft and parts (SIC 372), and measuring and controlling instruments (SIC 382).
Machining centers, Horiz., more than 27" Y axis	69.7 pct of respondents planning purchase are located in: Miscellaneous fabricated metal products (SIC 349), engines and turbines (SIC 351), construction, mining, oil field and material handling equipment (SIC 353), metalworking machinery and equipment (SIC 354), special industry machinery (SIC 355), general industrial machinery (SIC 356), miscellaneous machinery, exc. electrical (SIC 359), and aircraft and parts (SIC 372).
Machining centers, Vert., less than 20" Y axis	65.3 pct of respondents planning purchase are located in: Miscellaneous fabricated metal products (SIC 349), metalworking machinery and equipment (SIC 354), general industrial machinery (SIC 356), miscellaneous machinery, exc. electrical (SIC 359), motor vehicles, motor vehicle parts (SIC 371), aircraft and parts (SIC 372), and measuring and controlling instruments (SIC 382).
Machining centers, Vert., more than 20" Y axis	66.8 pct of respondents planning purchase are located in: Miscellaneous fabricated metal products (SIC 349), construction, mining, oil field and material handling equipment (SIC 353), metalworking machinery and equipment (SIC 354), special industrial machinery (SIC 355), general industrial machinery (SIC 356), miscellaneous machinery, exc. electrical (SIC 359), aircraft and parts (SIC 372).
Turning, Horiz., less than 13" chuck	64.9 pct of respondents planning purchase are located in: Screw machines products (SIC 345), miscellaneous fabricated metal products (SIC 349), construction, mining, oil field and material handling (SIC 353), metalworking machinery, exc. electrical (SIC 354), general industrial machinery (SIC 356), miscellaneous machinery, exc. electrical (SIC 359), motor vehicles, motor vehicles parts (SIC 371), and aircraft and parts (SIC 372).
Turning, Horiz., more than 13"chuck	68.1 pct of respondents planning purchase are located in: Miscellaneous fabricated metal products (SIC 349), construction, mining, oil field and material handling (SIC 353), metalworking machinery and equipment (SIC 354), general industrial machinery (SIC 356), miscellaneous machinery, exc. electrical (SIC 359), motor vehicles, motor vehicles parts (SIC 371) and aircraft and parts (SIC 372).
Turning, Vert., less than 30" dia table	56.3 pct of respondents planning purchase are located in: Metalworking machinery and equipment (SIC 354), general industrial machinery (SIC 356), miscellaneous machinery, exc. electrical (SIC 359), motor vehicles, motor vehicles parts (SIC 371), and aircraft and parts (SIC 372).

same situation exists in planned usage of cells and/or systems where a half dozen industries will account for half of the planned activity over the next three years.

We have displayed use and planned purchase activity for both cells and systems, as reported by respondents to the survey, in Table F.

Important Note: A manufacturing cell was defined in the survey as comprising one material handling device servicing multiple machines of which both are coordinated and paced by a computer or programmable controller. A flexible manufacturing system (FMS) was defined as comprising multiple materials handling devices servicing multiple machines with a computer responsible for coordinating, pacing and scheduling.

Robotics

Of the respondents, 34.5 pct report that they plan purchase of robotic devices between now and 1988. While that total decreased 2.4 pct from last year, it reflects installations over the past few years and the need to spend some time to determine how to better use these productivity assists. Noteworthy is the fact that 88 pct of the respondents that intend to purchase robots over the next three years employ 100 or more persons. A majority of robotic investment is made along with new purchases of machinery and equipment for manufacturing and assembly operations. Tie-ins with manufacturing cells and systems are obvious.

Other investment is not. Table G indicates the percent of respondents who plan robot usage or content in their anticipated purchases of production or assembly equipment.

Computers and Computerized Data Systems

Approximately four of five respondents plan to apply computers in their manufacturing operations over the next three years. While most of this activity will occur in plants employing 100 or more persons, 56.9 pct of those plants planning to install or expand the use of computers in manufacturing are located in plants employing 50-500. Only 16.6 pct in plants employing less than 50 persons.

Planned applications of computers in manufacturing are concentrated plant employment-wise in Table H.

Equipment Type	Most Active Purchasing Industries 1986-88
Turning, Vert., more than 30" dia table	65.0 pct of respondents planning purchase are located in: Engines and turbines (SIC 351), metalworking machinery and equipment (SIC 354), general industrial machinery (SIC 356), miscellaneous machinery, exc. electrical (SIC 359), aircraft and parts (SIC 372), and general missiles and space vehicles.
Boring	65.8 pct of respondents planning purchase are located in: Engines and turbines (SIC 351), construction, mining, oil field, and material handling (SIC 353), metalworking machinery and equipment (SIC 354), general industrial machinery (SIC 356), miscellaneous machinery, exc. electrical (SIC 359), electrical industrial apparatus (SIC 362), motor vehicles, motor vehicles parts (SIC 371), aircraft and parts (SIC 372), and general missiles and space vehicles (SIC 367).
Drilling	63.1 pct of respondents planning purchase are located in: Fabricated structural steel (SIC 344), miscellaneous fabricated metal products (SIC 349), metalworking machinery and equipment (SIC 354), special industry machinery (SIC 355), general industrial machinery (SIC 359), motor vehicles, motor vehicles parts (SIC 371), aircraft and parts (SIC 372).
Grinding	74.7 pct of respondents planning purchase are located in: Miscellaneous fabricated metal products (SIC 349), engines and turbines (SIC 351), construction, mining, oil field and material handling (SIC 353), metalworking machinery and equipment (SIC 354), special industrial machinery (SIC 355), general industrial machinery (SIC 356), miscellaneous machinery, exc. electrical (SIC 359), motor vehicles, motor vehicles parts (SIC 371), aircraft and parts (SIC 372).
Milling	67.8 pct of respondents planning purchase are located in: Cutlery, hand tools, hardware (SIC 342), engines and turbines (SIC 351), construction, mining, oil field and material handling (SIC 353), metalworking machinery and equipment (SIC 354), general industrial machinery (SIC 356), miscellaneous machinery, exc. electrical (SIC 359), electrical lighting and equipment (SIC 364), electrical component (SIC 367), motor vehicle, motor vehicles parts (SIC 371), and aircraft and parts (SIC 372).
Punching	54.4 pct of respondents planning purchase are located in: Metal, office furniture (SIC 252), fabricated structural steel (SIC 344), Forging and stamping (SIC 346), miscellaneous fabricated metal products (SIC 349), farm and garden machinery (SIC 352), construction, mining, oil field and material handling (SIC 353), special industry machinery (SIC 355), communications equipment (SIC 366), and motor vehicles and motor vehicles parts (SIC 371).

Table D

SIC	Industry	Pct Total Respondents Planning Offshore Sourcing	Pct of Appropriation Going Offshore
3429	Hardware, nec	69	34.3
3443	Fabricated plate work	33	45.0
3451	Screw machine products	50	53.6
3452	Bolts, nuts, rivets, washers	55	45.0
3469	Metal stampings, nec	51	36.4
3494	Valves and pipe fittings	55	41.1
3531	Construction machinery	71	43.3
3533	Oil field machinery	79	36.6
3541	Metalcutting machine tools	51	46.8
3544	Dies, tools, jigs, molds	53	49.4
3545	Machine tool accessories	55	56.1
3551	Food products machinery	65	40.1
3559	Special industry machinery, nec	44	49.2
3561	Pumps and pumping equipment	66	38.2
3562	Ball and roller bearings	67	37.1
3566	Speed changers, drives and gears	64	56.8
3569	General industrial machinery, nec	51	48.9
3599	Machinery, except electrical, nec	51	64.0
3621	Electric motors	65	41.2
371	Motor vehicles, motor vehicle parts	55	26.6
3724	Aircraft engines	76	41.5
3728	Aircraft parts	71	36.5
3811	Engineering and scientific instruments	58	46.8
382	Measuring and controlling instruments	62	31.6
384	Medical, dental and surgical instruments	63	34.5

Capital Spending

Table E

SIC	Industry	Pct of Respondents Planning Laser Purchase
34	**Fabricated metal products** Major purchase activity: Metal stamping (SIC 346), value and pipe fitting (SIC 3494)	13.2
35	**Machinery exc. electrical** Major purchase activity: Metalcutting machine tools (SIC 3541), tool and die (SIC 3544), machine tool accessories special industry machinery (SIC 355) general machinery (SIC 356) machines (SIC 357), miscellaneous machinery, exc. electrical (SIC 359)	34.4
36	**Electrical machinery** Major purchase activity: Electric motors (SIC 3621), industrial controls (SIC 3622), communications equipments (SIC 366), electron components (SIC 367).	19.5
37	**Transportation equipment** Major purchase activity: Motor vehicles, motor vehicles parts (SIC 371), aircraft and parts (SIC 372).	17.9
38	**Instruments** Major purchase activity: Measuring and controlling instruments (SIC 382), medical, dental and surgical instruments (SIC 384).	9.9

Table G

Of the Total Respondents Investing in	Pct Whose Purchase Includes Robotics
Metalcutting machine tools	13.0
Metalforming machines	10.9
Cleaning/finishing equipment	12.9
Assembly machines-equipment	29.3
Welding/riveting/brazing equipment	23.9
Heat processing equipment	6.8
Gaging/inspection/testing equipment	6.6
Material handling equipment	14.4
Plastic molding equipment	20.9

Table H

Computer Application	Planned Use Concentration by Plant Employment
Production control	Plants employing 50-500
Shop floor control	Plants employing 50-500
Machine loading	All sized respondent plants
Materials requirement planning	Plants employing 50-500 **NOTE: Most large plants (500+) have installed systems.**
Maintenance scheduling	All sized respondent plants
CAD/CAM	Plants employing 100 or more

Table F

Use and Planned Purchases-Cells

SIC	Industry	Cell Use Base: 254	Cell Purchase 86-88, Base: 389	System Use Base: 172	System Purchase 86-88, Base: 314
252	Metal office furniture	4	6	3	7
342	Cutlery, hand tools hardware	11	12	6	12
343	Heating equipment, exc electric and plumbing fixtures	7	8	-	-
344	Fabricated structural steel products	12	15	6	8
346	Forging and stampings	13	12	6	8
349	Misc. fabricated metal products	16	29	14	22
351	Engines and turbines	4	9	2	5
352	Farm and garden machinery	13	9	2	6
353	Construction, mining, oil fields & material handling equipment	8	13	8	11
354	Metalworking machinery and equipment	22	25	16	21
355	Special industry machinery	3	13	4	10
356	General industrial machinery and equip.	22	48	16	26
357	Office, computing and accounting machinery	7	9	9	7
359	Misc. machinery, exc. electrical	10	14	6	11
362	Electrical industrial apparatus	7	13	6	12
363	Household appliance	4	5	-	6
364	Electrical lighting wiring equipment	5	9	3	10
366	Communications equip.	5	11	6	12
367	Electronic Components	13	16	11	14
371	Motor vehicles, motor vehicles parts	23	33	14	24
372	Aircraft and parts	5	20	5	17
382	Measuring and controlling instruments	6	14	7	13
	Group Totals	**220**	**333**	**150**	**263**
	Pct of Base	**86.6%**	**85.6%**	**87.2%**	**83.7%**

Spending Patterns

For each of the nine production equipment categories shown below, the industries that are listed account for the bulk of the total 1986 investment by respondents in that type of equipment. Industries that are not listed are not making significant investments in equipment of that type according to respondents.*

Compare your company's investment pattern with your industry's spending plans by evaluating the percentage of capital investment budget that will be spent for each of these equipment categories.

**Note: These industries account for 75 pct or more of the planned investment for these types of equipment according to the PRODUCTION Magazine.*

Weld/Rivet/Braze Equipment

SIC	Industry	Pct of Reported Investment in Category
252	Metal office furniture	17.2
253	Public building and related furniture	17.3
254	Metal partitions and fixtures	4.7
343	Heating equipment, except electric and plumbing fixtures	4.8
344	Fabricated structural steel products	10.4
346	Forgings and stampings	3.6
348	Ordnance and accessories	3.5
349	Misc. fabricated metal products	4.7
351	Engines and turbines	3.7
352	Farm and garden machinery	8.9
353	Construction, mining, oil field and material handling equipment	9.3
355	Special industry machinery	4.7
356	General industrial machinery and equipment	3.1
358	Refrigeration and service industry machinery	7.3
361	Electrical transmission and distribution equipment	4.6
363	Household appliances	2.8
364	Electrical lighting and wiring equipment	6.6
371	Motor vehicles, motor vehicle equipment	5.9
372	Aircraft and parts	5.3
374	Railroad equipment	6.3
376	Guided missiles, space vehicles and parts	3.0
379	Transportation equipment, n.e.c.	14.0
382	Measuring and controlling instruments	4.2
384	Surgical, medical and dental instruments and supplies	3.9
386	Photographic equipment	12.5

Cleaning/Finishing Equipment

SIC	Industry	Pct of Reported Investment in Category
252	Metal office furniture	18.4
253	Public building and related furniture	19.1
254	Metal partitions and fixtures	12.3
341	Metal containers	9.6
342	Cutlery, hand tools, hardware	12.5
343	Heating equipment, except electric and plumbing fixtures	11.9
345	Screw machine products	8.3
346	Forgings and stampings	5.7
348	Ordnance and accessories	9.3
349	Misc. fabricated metal products	8.4
351	Engines and turbines	6.6
352	Farm and garden machinery	20.2
353	Construction, mining, oil field and material handling equipment	6.4
358	Refrigeration and service industry equipment	6.0
361	Electrical transmission and distribution equipment	8.4
364	Electrical lighting and wiring equipment	10.3
367	Electronic components and accessories	10.7
369	Misc. electrical machinery, equipment, supplies, n.e.c.	7.6
371	Motor vehicles, motor vehicle equipment	9.9
372	Aircraft and parts	7.2
374	Railroad equipment	23.0
376	Guided missiles, space vehicles and parts	9.1
381	Engineering, laboratory, scientific and research instruments	7.8

Metalcutting Machine Tools

SIC	Industry	Pct of Reported Investment in Category
345	Screw machine products	62.7
348	Ordnance and accessories	64.9
349	Misc. fabricated metal products	45.3
351	Engines and turbines	58.6
353	Construction, mining, oil field and material handling equipment	46.9
354	Metalworking machinery and equipment	72.1
355	Special industry machinery	57.0
356	General industrial machinery and equipment	56.9
359	Misc. machinery, exc. electrical	76.3
362	Electrical industrial apparatus	38.6
371	Motor vehicles, motor vehicle equipment	32.4
372	Aircraft and parts	61.3
374	Railroad equipment	33.4
381	Engineering, laboratory, scientific research instr	38.6
386	Photographic equipment	40.0

Heat Processing Equipment

SIC	Industry	Pct of Reported Investment in Category
342	Cutlery, hand tools, hardware	2.9
344	Fabricated structural steel products	1.8
345	Screw machine products	3.3
351	Engines and turbines	3.0
353	Construction, mining, oil field and material handling equipment	3.2
354	Metalworking machinery and equipment	1.5
356	General industrial machinery and equipment	3.4
357	Office, computing and accounting machinery	2.4
361	Electrical transmission and distribution equipment	3.8
362	Electrical industrial apparatus	1.8
363	Household appliances	2.0
371	Motor vehicles, motor vehicle equipment	1.6
372	Aircraft and parts	5.6
374	Railroad equipment	3.8
376	Guided missiles, space vehicles and parts	2.6
383	Optical instruments and lenses	10.8

Material Handling Equipment

SIC	Industry	Pct of Reported Investment in Category
252	Metal office furniture	11.8
253	Public building and related furniture	7.5
254	Metal partitions and fixtures	8.9
342	Cutlery, hand tools, hardware	9.3
344	Fabricated structural steel products	11.7
351	Engines and turbines	8.9
353	Construction, mining, oil field and material handling equipment	7.5
357	Office, computing and accounting machinery	12.1
362	Electrical industrial apparatus	6.1
363	Household appliances	10.4
365	Radio and TV sets	9.8
366	Communication equipment	7.0
369	Misc. electrical machinery, equipment, supplies, n.e.c.	14.7
371	Motor vehicles, motor vehicle equipment	5.8
384	Surgical, medical and dental instruments and supplies	9.1

Gaging/Inspection/Testing Equipment

SIC	Industry	Pct of Reported Investment in Category
345	Screw machine products	8.3
348	Ordnance and accessories	9.2
351	Engines and turbines	8.8
354	Metalworking machinery and equipment	8.3
355	Special industry machinery	8.6
356	General industrial machinery and equipment	7.0
357	Office, computing and accounting machinery	20.3
359	Misc. machinery, exc. electrical	9.5
361	Electrical transmission and distribution equipment	5.4
362	Electrical industrial apparatus	7.0
365	Radio and TV sets	8.8
366	Communication equipment	9.1
367	Electronic components and accessories	9.1
369	Misc. electrical machinery, equipment, supplies, n.e.c.	7.8
371	Motor vehicles, motor vehicle equipment	7.5
372	Aircraft and parts	7.2
381	Engineering, laboratory, scientific and research instruments	17.4
382	Measuring and controlling instruments	11.0
383	Optical instruments and lenses	15.7
384	Surgical, medical and dental instruments and supplies	10.2

Plastic Molding Equipment

SIC	Industry	Pct of Reported Investment in Category
341	Metal containers	17.0
342	Cutlery, hand tools, hardware	2.7
343	Heating, equipment, except electric and plumbing fixtures	6.4
344	Fabricated structural steel products	1.5
346	Forgings and stampings	3.0
349	Misc. fabricated metal products	2.0
355	Special industry machinery	2.8
358	Refrigeration and service industry machinery	3.5
361	Electrical transmission and distribution equipment	6.3
362	Electrical industrial apparatus	4.4
364	Electrical lighting and wiring equipment	7.5
365	Radio and TV sets	3.9
366	Communication equipment	2.1
367	Electronic components and accessories	5.2
369	Misc. electrical machinery, equipment, supplies, n.e.c.	6.5
371	Motor vehicles, motor vehicle equipment	1.5
379	Transportation equipment, n.e.c.	22.0
382	Measuring and controlling instruments	4.2
383	Optical instruments and lenses	7.2
384	Surgical, medical and dental instruments and supplies	6.1
386	Photographic equipment	10.0

Assembly Equipment

SIC	Industry	Pct of Reported Investment in Category
341	Metal containers	20.6
342	Cutlery, hand tools, hardware	15.0
357	Office, computing and accounting machinery	26.7
358	Refrigeration and service industry machinery	11.4
361	Electrical transmission and distribution equipment	36.6
362	Electrical industrial apparatus	19.1
363	Household appliances	19.8
364	Electrical lighting and wiring equipment	22.0
365	Radio and TV sets	53.9
366	Communication equipment	31.7
367	Electronic components and accessories	28.0
369	Misc. electrical machinery, equipment, supplies, n.e.c.	32.5
371	Motor vehicles, motor vehicle equipment	17.0
381	Engineering, laboratory, scientific and research instruments	17.4
382	Measuring and controlling instruments	26.5
383	Optical instruments and lenses	28.9
384	Surgical, medical and dental instruments and supplies	16.3
386	Photographic equipment	24.2

Metal Forming Machinery and Equipment

SIC	Industry	Pct of Reported Investment in Category
252	Metal office furniture	30.5
253	Public building and related furniture	23.9
254	Metal partitions and fixtures	59.7
341	Metal containers	45.7
342	Cutlery, hand tools, hardware	19.0
343	Heating equipment, exc. electric and plumbing fixtures	25.8
344	Fabricated, structural steel products	31.4
345	Screw machine products	12.0
346	Forgings and stampings	44.9
352	Farm and garden machinery	28.9
353	Construction, mining, oil field and material handling equiment	15.0
358	Refrigeration and service industry machinery	29.3
363	Household appliances	14.1
364	Electrical lighting and wiring equipment	18.8
371	Motor vehicles, motor vehicle equipment	13.1
379	Misc. transportation equipment, n.e.c.	29.0

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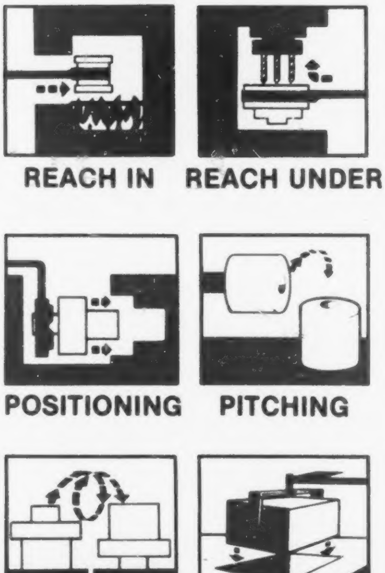

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CIM & JIT:

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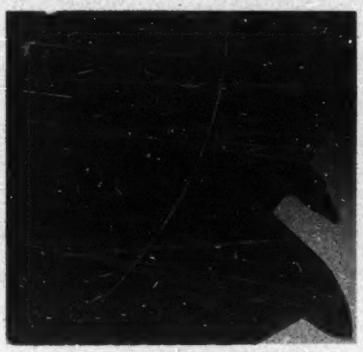

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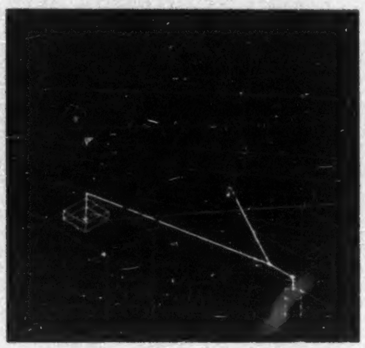

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WASHINGTON

Machine Tool Orders Up In January

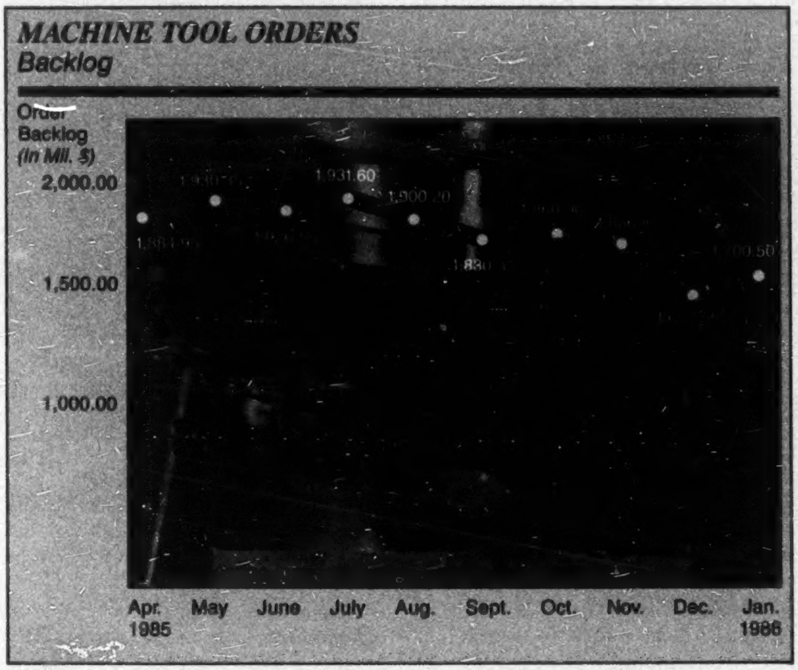
January orders for new machine tools posted a 7.8 pct increase over December's figures, a positive sign some manufacturing executives indicated for the year ahead.

New orders for the month totaled $188.65 million. However, total machine tool shipments stood at $145.7 million, down 61.1 pct from December, due to the year-end closing of work in process by machine tool builders, according to statistics compiled by the National Machine Tool Builders' Association (NMTBA).

While "mixed" was the key word for the state of the machine tool industry in 1985, some industry executives told PRODUCTION Magazine that 1986 is shaping up to be a good year for new orders.

"It's one hell of a year," beamed Mr. Henry Mamlok, president, Jacobson Tool & Manufacturing Corp., Skokie, Ill. "We're busier now than in the last three, four years." Mr. Mamlok said his company, which manufacturers spindle drilling and tapping machines, received a boost from military-related orders, but added that 80 pct of his business stemmed from new orders. "It's feast or famine in this business...1983 and '84 were slow, but business picked up at the end of 1985. I'm just about sold out for 1986 and its only February," he added.

Mr. James Bushong general manager, engineering & marketing div., Hitachi Seiki U.S.A., Inc., Congers, NY., echoed Mr. Mamlok's projection for 1986. "From our fiscal year (March 1985-March 1986) we had an all-time record high (in sales). Our next fiscal period should be just as good," said Mr. Bushong. He attributed the upturn in sales to the company's development of a new distributor base, and new product introduction.


MACHINE TOOL ORDERS
Backlog

Added Mr. H. Stanton Cheyney, vice president, marketing, Niagara Machine & Tool Works, Buffalo, NY, "Business is getting better...1985 was a super year and 1986 will be a good year, but not a boom year," he said. The company manufacturers straight-side presses, gap-frame presses, mechanical and hydrualic shears, CNC controls for shears, mechanical and hydraulic press brakes, and CNC controls.

However, not all executives were quite as optimistic. Mr. D. Feller, vice president, marketing, Strippit, Inc., Akron, OH, said that business is currently "flat" but leaning towards an "upturn." Mr. Feller said that Strippit, because it is in the forming-end of the industry, faces competition from foreign producers. He said as the dollar declines, the company should see improvement.

Overall, January 1986 orders were down 10.8 pct compared to January, 1985, Metal-cutting machine tool orders totaled $135 million for January 15.8 pct above December's level. Metal-forming machine tool orders however, came to $53.6 million, representing a decline of 8.2 pct from December.

Metal-cutting machine tool shipments, at $91.3 million, were down 68.3 pct from their December total of $287.9 million. Metal-forming machine tool shipments were $54.4 million, down 37.1 pct from the December figure of $86.5 million.

The shipments total of $145.7 million was down from December's $374.3 million, accounting for the 61.1 pct decline. January's shipments resulted in $1.7 billion backlog at the end of January, up from $1.6 billion at the end of December.

–Reported by
Tom Halligan/Philadelphia

WEST

Commercial Aircraft Industry Optimistic for Rest of Decade

With new airplane orders streaking in and market conditions bullish, commercial aircraft manufacturers are working on new technology programs and issuing optimistic market predictions for the remainder of the decade.

Airbus Industrie, the European manufacturing consortium that has been challenging America's predominance in the aerospace field, has been busily marketing its all-new A-320 single-aisle jet, which will be delivered to customers by the end of 1989. The A-320, which will make more extensive use of composites and alloys and come equipped with more fuel-efficient engines than present conventional commercial jets, already is being assembled in stages at the factories of the consortium partners.

Final assembly will occur at Airbus' facility in Toulouse, France.

Ninety firm orders for the new airplane have been received. Option orders have climbed to 257.

Encouraged by its success and eager to expand its product line to more forcefully compete with large U.S. manufacturers like The Boeing Co. and McDonnell Douglas Corp., Airbus officials are moving ahead with plans to develop two additional new aircraft.

An estimated $2.5 billion will be spent on the new programs, with an official production launching set for early 1987.

The first of these two new Airbus aircraft, the A-330, will be a twin-engine plane with a 320 seating capacity and a 5,000 mile range.

The second, the A-340, will come equipped with four engines, seat 260 and cruise some 6,800 miles.

The two new planes will share common fuselage, wing, cockpit and control designs. A new variable camber wing design which will reduce fuel consumption is being tested by the Airbus partners.

Airbus officials said the A-340 will offer aircraft mile costs approximately 30 to 35 pct lower than the Boeing 747-200. The A-330 will come in about 7 to 10 pct below the 747.

Not to be outdone, archrival Boeing recently released a picture of its all-new 7J7 jet, a 150-seat airliner that won't be delivered until 1992.

Boeing hopes the plane will be a foil to the new Airbus A-320. Although the Airbus jet will beat Boeing to the market by a couple of years, Boeing officials believe the design of the 7J7, which is expected to include all-new propfan engine technology, will be such an improvement that it will help make the A-320 nearly obsolete.

The airplane will make extensive use of lightweight materials, fiber-optic control systems, advanced airfoils and more compact flight control actuators.

More than 700 personnel are working on the new project.

The Douglas Aircraft subsidiary of McDonnell Douglas Corp. also is working on new derivative airplanes, including the MD-11, a wide-cabin trijet that will replace the DC-10 and compete with the 747 and the A-330 and A-340.

But Douglas, like Boeing, is investing heavily in research and development of the propfan—also known as ultra-high bypass—engine technology. Douglas planners believe the new engines could improve fuel efficiency from 25 to 30 pct over the best conventional jet turbofans. Airbus has been less optimistic about the engine breakthroughs than its two American rivals.

The new program activity is easy to understand. All three competing manufacturers are coming off high-flying years. Airbus logged 92 firm orders for new airplanes in 1984, making it one of the best years in the company's history.

"We can all be proud of our achievements in 1985," said Jean Pierson, Airbus Industrie president. "But there is no room for complacency in a technologically competitive industry such as ours."

Indeed not. Boeing logged 390 firm orders in 1985, compared to 168 in 1984. It was the company's third highest year for new aircraft orders in history.

There could be much more of the same in the years ahead. Douglas estimates that during the next 15 years a potential market exists for more than 5,400 new passenger aircraft units valued at nearly $249 billion in 1985 dollars.

COMMERCIAL TRANSPORTATION AIRCRAFT SHIPMENTS

	General Aviation	$ Amount (Bil.)
1985	277	$8.499
1984	185	$5.689
1983	262	$8.000
1982	232	$6.246
1981	387	$9.706

Source: Aerospace Industries Assoc.

After a lackluster performance in 1984, commercial aircraft orders took off in 1985. Orders are expected to remain at a high level through the end of the decade.

General Aircraft Industry Struggling

America's general aircraft industry is struggling through another difficult year, with proposed tax law changes, uncertain capital spending and strong foreign competition all combining to drag down the industry.

Unlike their larger counterparts in the commercial airframe manufacturing industry, the smaller makers of business aircraft have yet to see the industry emerge from a recession that took root four years ago.

"This year will be another year of great challenge," said Thomas J. Smith, chairman of the General Aviation Manufacturers Association and president of Fairchild Aircraft Corp.

"We make no representation that the turn-around is in sight. But general aviation manufacturers are moving in new directions to face the future, to fit new marketplace realities, to find solutions that will allow us to grow in the future. General aviation is changing. We're changing with it," Mr. Smith said.

The changes, however, have been very painful for the smaller business aircraft manufacturers. Some companies have merged. Others have cut back their product lines and charted layoffs.

The Boeing Company recently finalized its purchased of the troubled de Havilland Aircraft of Canada, which produces regional commuter aircraft. Boeing plans to fund new product development and upgrade facilities.

Lear Siegler Inc., which is headquartered in Santa Monica, Calif., recently announced that it was temporarily suspending production of most Piper airplanes because of falling demand.

The discountinued models, which are all piston-powered, include the Warrior, Archer, Dakota, Turbo Arrow, Saratoga SP, Turbo Saratoga SP and Chieftan. Analysts expect Lear's Piper unit to lose more than $20 million in the 1986 fiscal year than ends June 30, double last year's losses.

Gates Learjet Corp., which is based in Tucson, Ariz., also has suffered losses and recently pulled out of a joint venture with Piaggio of Italy to produce a new business jet because it couldn't afford the research expenses involved.

James B. Taylor, the company president, said 1985 was a difficult year for Gates. "We have spent the last six months posturing the company to work our way out of some severe problem areas," he said.

"Much of this effort is now behind us and I feel we are on solid ground for the future," said Mr. Taylor.

Gates lost $10.6 million in 1984 and was expected to post a slightly larger loss in 1985.

GENERAL AVIATION AIRCRAFT SHIPMENTS

	General Aviation	$ Amount (Bil.)
1985	2,032	$1.42
1984	2,432	$1.68
1983	2,691	$1.47
1982	4,266	$2.00
1981	9,457	$2.92

Source: General Aviation Manufacturers Assoc.

The general aviation industry is in the doldrums as deliveries in 1985 continued to sag well below the 1981 total of $2.9 billion.

In response, Gates has launched an aggressive marketing effort for 1986, which includes export customers like the People's Republic of China. The company also has been attempting to diversify its product base; it won a $14 million subcontract last year from Martin Marietta to build space shuttle components.

Gates also installed new management. And the firm closely evaluated its manufacturing operations in Tucson and Wichita and decided, despite the difficulties, to reverse an earlier decision and keep both facilities operating.

"Even though the business and corporate aircraft market has not returned to the levels experienced in the early 1980s, I believe one positive aspect of this thorough study has been to posture the company for the future," explained Mr. Taylor.

"Actions taken to enhance marketing and reduce operating costs by the company's new management team have resulted in substantial progress toward returning Gates Learjet to profitability," he added.

Such problems likely will continue to impact the entire general aircraft market through the remainder of this year.

GAMA officials expect little increase in corporate capital spending, which will depress orders for more expensive business jets. Proposals to change tax regulations and the potential loss of the Investment Tax Credit also is hurting the industry.

On the positive side, GAMA reported increased sales to military and government buyers and increasing business in retrofits.

GAMA reported deliveries and billings were down in 1985. Turboprop deliveries rose 19.6 pct. But jet sales were down 15.3 pct and single engine deliveries fell 15.4 pct. Deliveries of piston twin aircraft fell 48 pct.

IBM, DEC Vie For Plant-Level Computer Mart

The race between IBM and DEC to out-distance each other in the plant-level computer market is taking a new turn.

According to the Yankee Group, a Boston-based market research firm, IBM will (through its direct and third-party marketing channels) rack up 46 pct of the total U.S. market for computers at manufacturing facilities. DEC placed second with (through all channels) more than 22 pct of the market.

However, IBM and DEC have widely different positions in segments of the manufacturing computer market, according to the research firm.

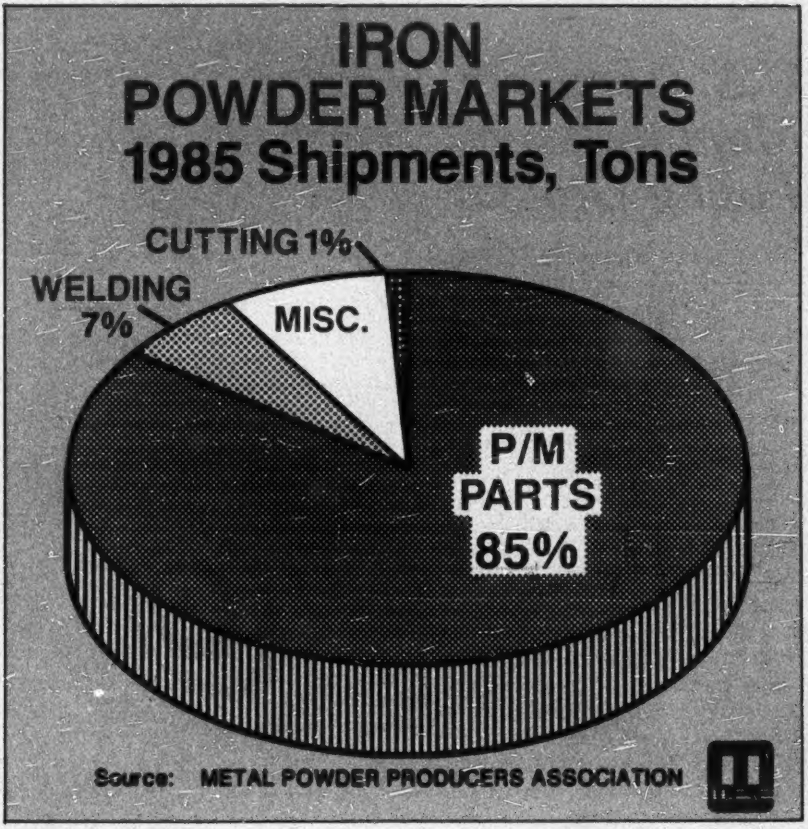
Although IBM is first in the market for large computers running plant-wide applications, it is second in the market for supervisory-level computers, which coordinate multiple work cells. DEC's position is the reverse. The company is first at the supervisory level, but is intent on attracting a larger share in the plant-level computer market.

According to the Yankee Group, DEC has made inroads into IBM's market at a better clip than IBM's has into DEC's market. The firm said that DEC "may be capturing the U.S. automation leaders at large manufacturing sites."

Further findings indicated that DEC's franchise is in large manufacturing sites. DEC has a stronger position among large users than it does overall, both on its traditional supervisory-level market and at the plant level. IBM has not made significant inroads at the supervisory level at large user-sites as it has made in the overall market, according to the survey.

It is estimated that plants with more than 500 employees accounted for 65 pct of the total manufacturing computer dollars in 1985.

–Reported by
Sandra Brooks/Chicago and
Robert Huber/Detroit



Source: METAL POWDER PRODUCERS ASSOCIATION

EAST

Metal Powder Group Bullish on Growth

The Metal Powder Industries Federation (MPIF) is bullish on the potential growth of the industry in the near future.

The MPIF cited a recent study it conducted that indicated the conventional powder metallurgy (PM) parts business could consume an additional 650,000 tons of iron, copper, stainless steel and aluminum powders, representing more than three times current usage.

According to Kempton H. Roll, MPIF executive director, PM has the capability from a design, performance and cost effectiveness point of view to take business away from the stamping, forging, casting, machining and plastics industries.

Permanent mold casting, screw machining, broaching and plastic compression molding offer the greatest potential for PM inroads, according to Mr. Roll. A net-shape forming process, PM offers significant raw materials and energy savings, excellent tolerance and weight control on metal parts and very favorable cost savings, Mr. Koll added.

He cited the U.S. automotive industry, which is converting significant numbers of parts to PM from castings, forgings and machined parts, in an effort to more effectively compete in the world market.

In order to further spread the word on the benefits of PM, the MPIF is continuing its marketing program begun in 1983 to educate design engineers and the general industrial public about the advantages of using PM.

U.S. Abrasives Manufacturers Losing Ground

The abrasives industry, facing a continually shrinking market because of foreign competition, projects 1986 to closely mirror 1985, continuing the decline of the total size of the U.S. market projected to slip by 1 to 2 pct over the next few years.

Unit sales for bonded and coated abrasives in the U.S. last year were generally below projections, according to Robert N. Hamilton, vice president, Abrasives Marketing Group, Norton Co., Worcester, Mass. Major consumers of abrasive products such as primary metals, construction equipment, forest products and machine tools were less active than forecast. Moreover, there was also some adjustment of inventories in early 1985, due to 1984 inventories which were not used as quickly as planned, Mr. Hamilton said.

"More importantly for the long-term was that in 1985 the abrasives industry strongly felt the impact of permanently shrinking markets," continued Mr. Hamilton. "Abrasives have always been a cyclical business. Over the past few years, however, several factors have caused a basic restructuring of our primary markets. For instance, the industries that represent the major users of abrasive products in the U.S. have gotten permanently smaller because of foreign competition," he said.

Mr. Hamilton stressed that other U.S. industries, such as automobiles, import major end-product components. "Thirty percent of a typical U.S. car is made outside the U.S.; unfortunately for the abrasives industry, that thirty percent represents much of the grinding. The cars that are made here are smaller, requiring less use of abrasives," Mr. Hamilton said.

Mr. Hamilton projected that 1986 unit sales of abrasives will remain flat over 1985.

–Reported by
Tom Halligan/Philadelphia

GEORGIA'S AEROSPACE COMPANIES SPAN BROAD RANGE

LOCKHEED-GEORGIA 18,000 employees	Large transport, airlift aircraft
GULFSTREAM AEROSPACE 3,500 employees	Corporate jet aircraft
ROCKWELL MISSILE SYSTEMS 1,300 employees	Tactical missiles, subassemblies
CALCUSEARCH Seven employees	Aircraft test scale models
CHEROKEE TOOL 20 employees	Aircraft parts
AID CORP. 50 employees	Aerospace components

Source: AIDC's High Tech Industries in Georgia, 1985.

SOUTH

Georgia Quietly Rising As Aerospace Industry Hub

Georgia's renowned Southern charm and hospitality is quietly enticing a notable amount of aerospace and defense-related industry to the state.

Preliminary findings from a soon-to-be-published study, conducted by Georgia Tech, confirm that Georgia is currently home to 178 aerospace-related companies. The state is working with another 50 or so active prospects in the aerospace and defense-related industries interested in joining those already established.

Of the 178 companies, slightly more than a quarter classify manufacturing as their primary business activity. Manufacturers account for over 95 pct of the more than $800 million in investment in property, plant, and equipment (before accumulated depreciation) in the state's aerospace industry.

The research indicated that total aerospace employment in the state is 27,590, distributed primarily among those in jobs as production workers (45 pct), technicians (26 pct), and scientists and engineers (14 pct). Most of the employment is concentrated in metropolitan Atlanta (skewed by Lockheed-Georgia Co.'s presence there), though pockets of aerospace employment exist across the state.

Georgia's aerospace industry stretches across not only a wide geographic span, but also a wide range of sizes. According to the study, 54 pct of the state's aerospace companies employ 25 persons or fewer. In recent years especially, small aerospace technology ventures have sprung up near Georgia Tech.

The solid growth of the state's aerospace industry has been neither an accident nor the simple consequence of Southern hospitality. Rather, the combination of several key factors has been responsible.

"Georgia has built up the critical mass needed for the state to be a magnet for aerospace industry," said John

Warden, project manager for the Georgia Tech study. Mr. Warden and state economic development experts cited several key elements to Georgia's attractiveness as a location for aerospace companies:

—Large military installations: The U.S. Air Force base at Warner Robins, near Macon, registered more than $1 billion in aerospace goods and services expenditures in 1984. Proximity to large bases is often attractive to suppliers.

—Strong educational base: Georgia Tech ranks eighth nationally in R&D expenditures for aerospace/astronautical engineering and is the acknowledged leader in rotary-wing aircraft technology. Tech has both spawned small aerospace companies and has been a magnet for others needing access to its technological capabilities and expert engineers. Technology-dependent companies "need brain power to lead or at least keep up," said Mr. Warden. Though scientists and engineers make up only 13.5 pct of Georgia's aerospace employment, they form the most critical component.

—Congressional clout on defense matters: A less direct, though clearly important factor in Georgia's aerospace growth is the state's long tradition of congressional clout on defense.

The legacy of leadership has been passed on by the likes of former Senator Richard Russell and former Congressman Carl Vinson, to Sen. Sam Nunn (D), now ranking minority member of the Senate Armed Services Committee.

—Creative incentives: Over the years, Georgia has been innovative in designing attractive incentives for both new and relocating companies in technology industries, including aerospace. Since 1978, 86 high-technology companies moved to Georgia from other states.

The state's economic development office intends to use the study's research to help attract still more aerospace industry to Georgia.

–Reported by
Leslie Goldwater/Atlanta

EUROPE

GM Forms European Organization

General Motors recently announced in London that it is setting up a European organization to coordinate the activities of GM companies in 17 countries. The new group will be called General Motors Europe—Passenger Cars, and will be based in Zurich, Switzerland.

One hundred of the proposed 200 employees will be drawn from Opel in Germany (Zurich is German-speaking) and the others will come from GM companies all over Europe.

GM said the new organization has become necessary because of the growing importance and competitiveness of the European car market. The area produced 10.7 million cars in 1984 (compared with 8.8 million in the U.S. and just over 7 million in Japan) and this figure is forecast to rise to 12.3 million by 1990.

"Our substantially increased car sales in Europe, a competitive situation that calls for quick decisions and an environment that is becoming increasingly complex and interconnected, all demand strengthened coordination among our European operations," noted GM president James MacDonald.

The new organization follows the pattern of Ford Europe, set up around 16 years ago, in that it has no legal status and serves in an advisory capacity. The legal and business situation of the various national GM companies will not change.

GM produced 1.2 million cars in Europe last year. The group's share of the fiercely-contested Euro market has steadily increased from 9.6 pct in 1982 to over 11.4 pct last year. This puts the American giant up with Volkswagen, Fiat, Ford, PSA and Renault in a struggle for market leadership with only 2 pct difference among the top five.

However, GM's two main producing units, Opel and Vauxhall, have both been losing money. GM sustained a net loss in Europe of $291 million on total sales (including parts and trucks) of $7 billion. This has led to accusations that GM has been buying market share to overtake Ford outside the U.S.

Asea Acquires VS Technology

Asea Holdings Ltd, the British end of the Swedish electrical giant, is to acquire the VS Technology group, a British high-tech automation company.

VS mainly builds systems for the motor industry and scored a world first when it designed and supplied the robotic glazing system for the Austin Rover Montego assembly line, which included vision sensing. In recent years, VS has developed expertise in vision control, machine intelligence, automated adhesive technology and automatic assembly.

The acquisition will fit in very well with Asea Robotics, which in recent years has established itself as Europe's biggest robot manufacturer. Percy Barnevik, Asea's 44-year-old chief executive, said recently that Asea intended to establish a stronger presence in the UK and was on the lookout for likely acquisitions.

It is presently not known if Asea is interested in making a bid for Fairey Automation, which is being sold off by its parent company. There has been speculation that DEA, the Italian robotmaker, may want to acquire Fairey (mainly because the two firms have a licencing agreement) but this is denied by the British company. However, a spokesman for Fairey said that "it is having discussions with a number of intersted parties."

–Reported by
Peter Mullins/Great Britain

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MAY 1986

FOR MANAGERS OF MANUFACTURING TECHNOLOGY

What Makes the Best Plants Go

**GM's Orion,
Wentzville,
Hamtramck,
and Wilmington
Plants**

**Chrysler's
Sterling Heights
and Windsor
Assembly
Ford's Chicago
Assembly**

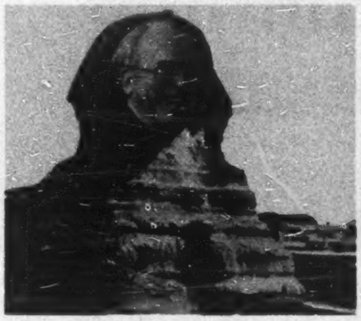
**Fiat's Termoli
Ford's Scorpio**

Mazda's Hofu

PRODUCTION

MAY 1986 VOL. 97 NO. 5

COVER-TO-COVER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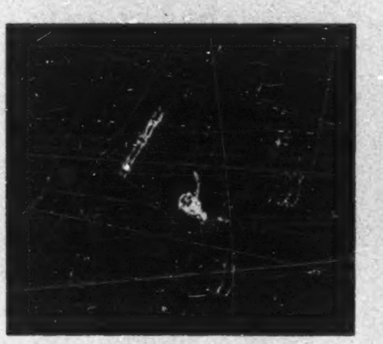
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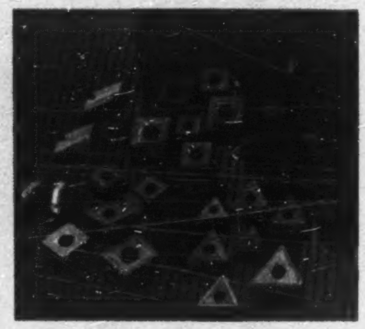
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show, with leading sponsors, and a wider variety of technical seminars, SMTS-87 will attract a maximum of top-quality visitors with buying interest and authority, the NMTBA said.

Regional shows like SMTS-87 will reach beyond the bounds of present local shows. Instead of catering just to "drive-in" visitors, SMTS-87 will be promoted to every manufacturer and their key engineers and manufacturing staff within an hour's plane flight of Charlotte. This area encompasses a third of the American population and as much of the manufacturing and metalworking industry as the equivalent areas surrounding Boston or Los Angeles.

Exhibit space is being assigned now. For more information contact: Mr. Elwood Hasemann, Exhibition Director, National Machine Tool Builders' Association.

–Eastern region reported by Tom Halligan/Philadelphia

WASHINGTON

Reagan Mulling NMTBA Petition For Quotas

President Reagan is considering the National Machine Tool Builders' Association's (NMTBA) three-year-old petition for protection from foreign imports of machine tools.

The NMTBA petition seeks five years of import quotas on machine tools stemming from a national security clause—section 232, of the 1962 Trade Expansion Act.

However, there is strong indication from the White House that the President will deny the NMTBA petition for strict quotas, but in turn will try to negotiate a restraint agreement with Japan.

The NMTBA is particularly concerned with imports of Japanese machine tools that could hinder the readiness of the U.S. military in time of conflict.

Machine Tool Orders Continue to Climb

New orders for machine tools in February surged to $211 million, up 10.7 pct over January's figures, according to statistics compiled by the National Machine Tool Builders' Association (NMTBA).

However, measured against a year ago, February's total net new orders were off 11.1 pct., continuing the decline of new orders which have fallen for the eighth consecutive month compared to the same period the year before.

Metal cutting machine tools increased 25.0 pct in February, up from $135 million to $168.8 million. Conversely, new orders for metal forming machine tools declined 24.1 pct to $42.3 million from January's $55.8 million figure.

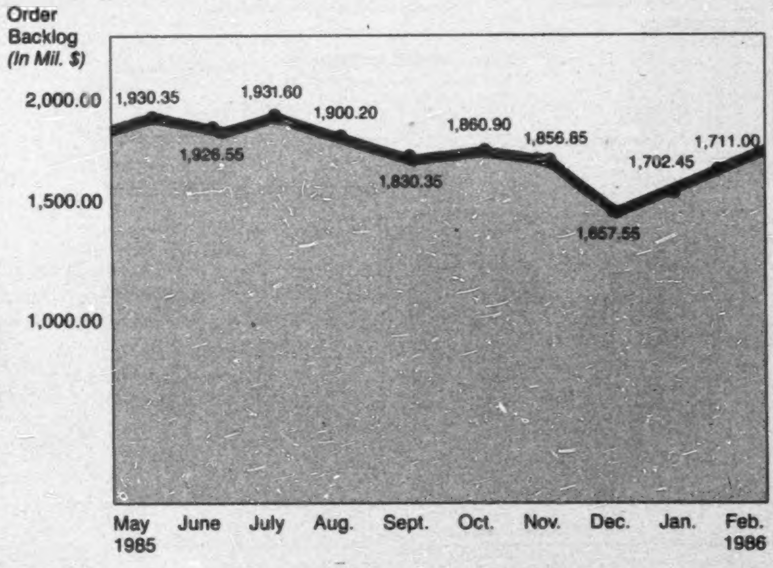
"We are seeing an increase in shipments, which certainly helps cash flow, but still no turnaround in net new orders," commented James Gray, president, NMTBA. "The manufacturing industries are caught in the middle as Congress and the President debate the various tax proposals. Up to a point, we are optimistic about the future as American industry moves to modernize and improve its competitive position," he added.

Total machine tool shipments for February stood at $202.6 million, up 38.9 pct over January, and a healthy 21.8 pct increase over February 1985.

February's metal cutting shipments totalled $124 million, up 35 pct over January. At $78.6 million, metal forming shipments increased 44.6 pct from January's totals.

The industry's order backlog rose to $1,711 million in February, up slightly from $1,702 in January.

MACHINE TOOL ORDERS
Backlog



MAP—What It Means To You

While the standard has been set, its implementation must now take place. Scores of vendors are developing MAP-compatible products which will make this growing phenomenon a part of your manufacturing operation in the near future.

By Sandra Brooks
Midwest Regional Editor

THE MANUFACTURING AUTOMATION Protocol (MAP), General Motors' demand to standardize communications methodology so that its more than 40,000 intelligent devices scattered across 14 plants can intercommunicate, has emerged as the de facto standard.

However, it is important to distinguish between MAP, the document and MAP, the tangible product. Today, the product does not exist.

The MAP document, Version 2.1, is comprised of a selection of available communications standard protocols and GM specifications covering topics for which no standards exist. The effort was initiated in April 1980 by a GM task force, drawing from the work of five organizations, including the International Standards Organization (ISO), the American National Standards Institute (ANSI), the Computer and Business Equipment Manufacturers Organization (CBEMA), the Institute of Electrical and Electronic Engineers (IEEE) and the National Bureau of Standards (NBS).

By June of 1982, GM had formally adopted MAP as a communications standard and requested that suppliers follow the MAP specification for interconnection. The political turmoil among vendors who vied to protect their proprietary communications protocols (and gain market share) by becoming sole vendor to GM was fueled when GM organized the first MAP Users Group meeting in March 1984 at McDonnell Douglas in St. Louis.

That single action propelled GM's effort into the public domain.

In the two years since, membership in the MAP Users Group has grown to include 800 companies and individual members. Throughout the world, complementary organizations, including the Canadian, European and newly-organized Japanese and Australian MAP Users Group organizations, continue to drive the MAP effort with their interest and support.

The development of MAP however hinges upon the *process* of needs evaluation, commercialization of technological solutions and trial-and-error use.

Just what MAP ultimately will be remains to be seen. Version 2.1, released in March 1985 will be supplanted by V.3.0 early in 1987—V.2.2, primarily the addition of a carrier-band specification, will be released late in 1986.

Upward compatibility of V.2.1 to V.2.2 is inherent to the enhanced specification. However, migration from V.2.“x” to V.3.“x” will require considerable software modification and, possibly, the use of gateway-like hardware.

Before you suck in your breath as you prepare to approach your financial officer for additional MAP funds to achieve this migration, remember that a tangible MAP does not exist. If you are among the increasing number of network users, yours is, at best, MAP-*compatible*, not MAP-*compliant*. Therefore, routers, bridges, gateways and software translators already reside somewhere on the network. The worst case scenario is that users will need to write a few lines of a new code.

Sorting It Out

Countless documentation addressing MAP—has been published over the past two years. ISO/OSI, 802.“x”, x.“y”, RS“n”, ISA, CCITT, HDLC, NIU, TIM, MMFS, FTAM, EPA; all permeate the alpha-numeric computer soup through which potential users must wade—the important question is: What Do You Do With It?

Specifications, protocols and standards are critical elements to the development and universal implementation of technology. But, they are not the technology. They are not the implementation, and they are not the solution.

MAP is not an entity unto itself—rather, it is an integral part of the global CIM concept.

GM has a very real need for computers, robots, programmable controllers and other automation-related equipment.

The Japanese have had an impact on GM's decision to implement MAP. GM realized that in order to effectively compete with Japan it needed to improve quality and the cost to the consumer. From the production perspective this implies a dramatic reduction in scrap and rework, significantly lower material inventory and productivity increases. This means that there is the ability to quickly change existing line production from one product to another, rather than continually building additional lines to accommodate new products and the capability to increase demand while other plants operate below capacity.

The reality of MAP is that it is another automation tool. A very powerful tool, but its order of magnitude will be directly proportional to understanding the tool and its implementation.

MAP is not a panacea for manufacturing ills. It will be incumbent upon the user to identify the proper location of an intelligent device, assess its function, determine what information needs to be collected, identify where that information needs to go, specify what will be done with the information when it arrives. In order to accomplish this, users must analyze their entire operations—not only the shop floor—but the *functional* interrelationships of all departments from the boardroom to the toolroom, from plant to plant, down through the supplier network. MAP will not do that job for you.

What it will do, however, is to put the resources you need to drive an effective, responsive and competitive organization easily within reach.

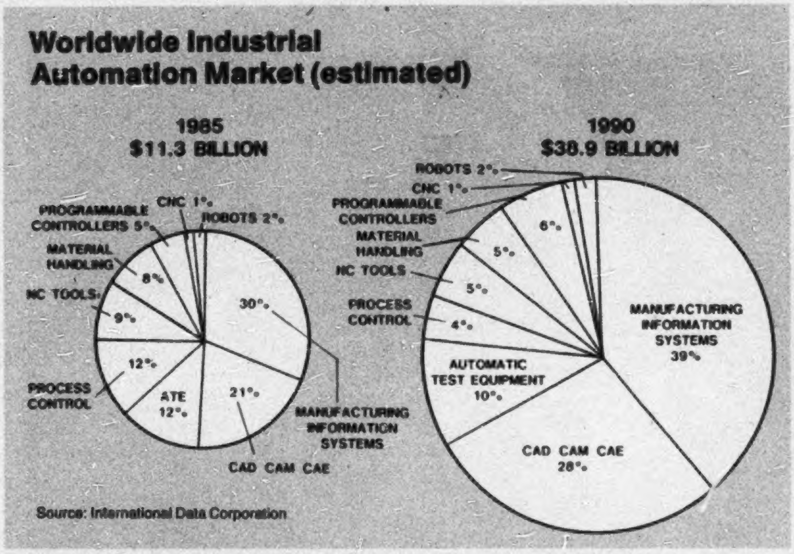
The Users

Beside the flurry of activity to develop MAP, to a completed, accepted world-wide compilation of standards rests a handful of pioneers who are leading the way with the implementation of available products. Currently no implementation of the MAP specification V.2.1 exists. However, the number of MAP-compatible proprietary broadband network continues to grow and increase in its function.

At GM, a network of implementation compatible with MAP V.2.0 have been completed at the B-O-C plant in Ham-

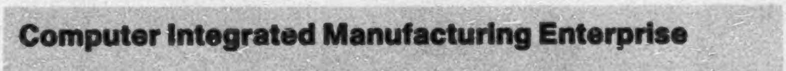
GM'S MAP Program Is Expected To Have A Far-Reaching Impact

Illustration by Tom Barrett



Source: International Data Corporation

The worldwide automation market (above) is estimated to be $38.9 billion by 1990 as shown in the chart. As the implementation of MAP technology continues to grow, the elements of automation equipment market will be affected including producers of robots, CNC equipment, programmable controllers, material handling devices, numerical control tools, process control equipment, MIS, CAD/CAM and CAE and automatic testing equipment. Vendors of this type of equipment will be impacted by its continuing use in the manufacturing environment.


Computer Integrated Manufacturing Enterprise
MANUFACTURING MANAGEMENT & HUMAN RESOURCE MANAGEMENT
FACTORY AUTOMATION
PRODUCT/PROCESS
FINANCE
MARKETING
MANUFACTURING PLANNING & CONTROL
STRATEGIC PLANNING
MATERIALS PROCESSING
DESIGN
ANALYSIS AND SIMULATION
DOCUMENTATION
QUALITY PROCESS & FACILITIES PLANNING
SCHEDULING
MATERIAL
SHOP FLOOR
MATERIALS HANDLING
ASSEMBLY
INSPECTION/TEST
INFORMATION RESOURCE MGMT. & COMMUNICATIONS
COMMON DATA
INTEGRATED SYSTEMS ARCHITECTURE

CIM "Wheel" developed by the Technical Council of the Computer and Automated Systems Association of SME (CASA/SME)—Copyright 1985 CASA/SME Second Edition, Revised November 5, 1985

MAP is not the entity unto itself–rather it is an integral part of the global CIM concept.

tramck, Mich., and at the C-P-C plant in Bowling Green, Ky., according to Mark Cocroft, advanced product and manufacturing engineering staff, GM Tech Center.

Two major networking projects are slated for this year; one at Saginaw Div. (Factory of the Future) which will run through 70,000 sq. ft. of the facility and would integrate machining, robots, assembly and automated guided vehicles (AGVs). The other, known as GMT 400, would encompass five truck plants—metal stamping operations at Indianapolis, Ind. and Flint, Mich. and assembly operations at Oshawa, Ont., Pontiac, Mich. and Ft. Wayne, Ind.

Indianapolis and Flint have no commitment to run MAP. The reasons are simple; the equipment does not support MAP and the implementation of gateways rather than using cell controllers would increase network costs by at least $3-million, explained Marnie Lerums, of EDS.

In April 1985, Kaiser Aluminum began installing its MAP-compatible proprietary network at its Erie, Pa., forging plant. More than 150 different pieces of equipment, and an energy management system, have been integrated on the largest Concord Data network in the U.S., according to Bill Geibel, staff research engineer responsible for the implementation.

It was put into operation in July 1985. "It immediately gave us the ability to look at the whole plant (17 buildings on 26 acres) as a single, continuous process," said Mr. Geibel.

The critical part of the network is a detailed specification and integration plan, according to Mr. Geibel. "We learned each operation, we analyzed how communications were being transacted, we made sure we'd never need to rewire and we planned for the worst," said Mr. Geibel.

Installation problems were minimal—although there were some instances of bad connections and a need to insulate the equipment from extreme temperatures.

"While we can't show an increase in revenue due to the network until the end of the fiscal year, we know we're cutting costs," Mr. Geibel stated. "Initially we monitored peak power usage. One of the things we monitor is electrical usage. We discovered that peak demand occurs after lunch break. By rescheduling the work force, we're saving $8,000 per day without changing the operation. That alone will payback the cost of installation within 12-18 months," said Mr. Geibel.

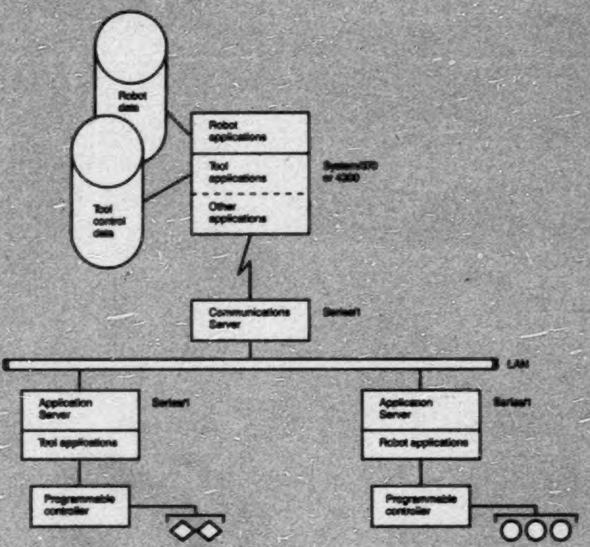
Deere & Co. has earned several distinctions in the networking arena. In 1981 the first Computer and Automated Systems Association (CASA) awarded the Lead Award to the Tractor Works in Waterloo, Iowa; in February 1985 the first production implementation of a MAP-compatible network at the Farm Combine factory, East Moline, Ill.; and its current effort is the installation of a MAP-compatible proprietary network (Allen-Bradley Data Highway) at the 2.8 million sq. ft. plant in Des Moines, Iowa.

The initial Des Moines network implementation will focus on three cells—turret punch press, tubing and robotics—which will be phased into production over the next 6 to 12 months. Driven by an existing DNC control and the need for increased security, the multi-media broadband network ultimately is intended to support video, voice, fire detection, card access/gate controllers, coordinate measuring machines (CMMs), personal computers, graphic engineering workstations and programmable controllers. The network also will feature a mini-MAP (EPA) carrier-band subnet for real-time control.

Deere has invested well over $1-million in its networking efforts. According to Dave Scott, division manager Computer-aided Manufacturing Services, Moline, Ill., "justification has been based on R&D."

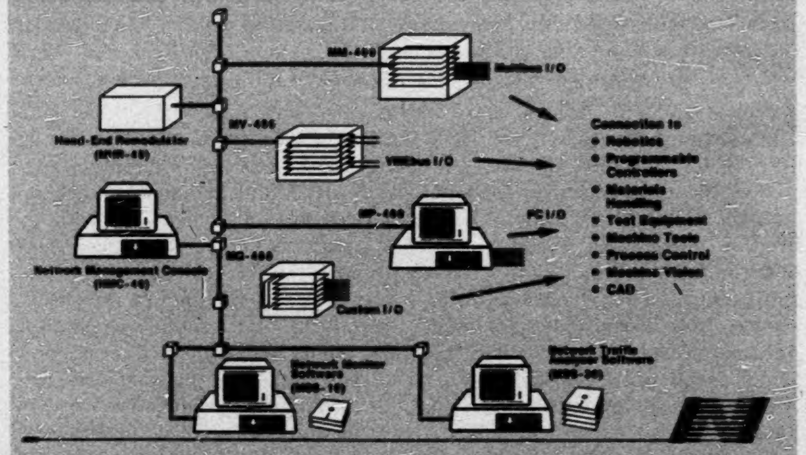
"By approaching MAP with the utility philosophy to build a plant-wide communications infrastructure, we gain experience. We don't have any quantitative results yet, but we have everything to gain and nothing to loose," Mr. Scott said.

Integration of Plant Automation


Robot data
Tool control data
Robot applications
Tool applications
Other applications
System/370 or 4300
Communications Server
Series/1
LAN
Application Server
Series/1
Tool applications
Application Server
Series/1
Robot applications
Programmable controller
Programmable controller

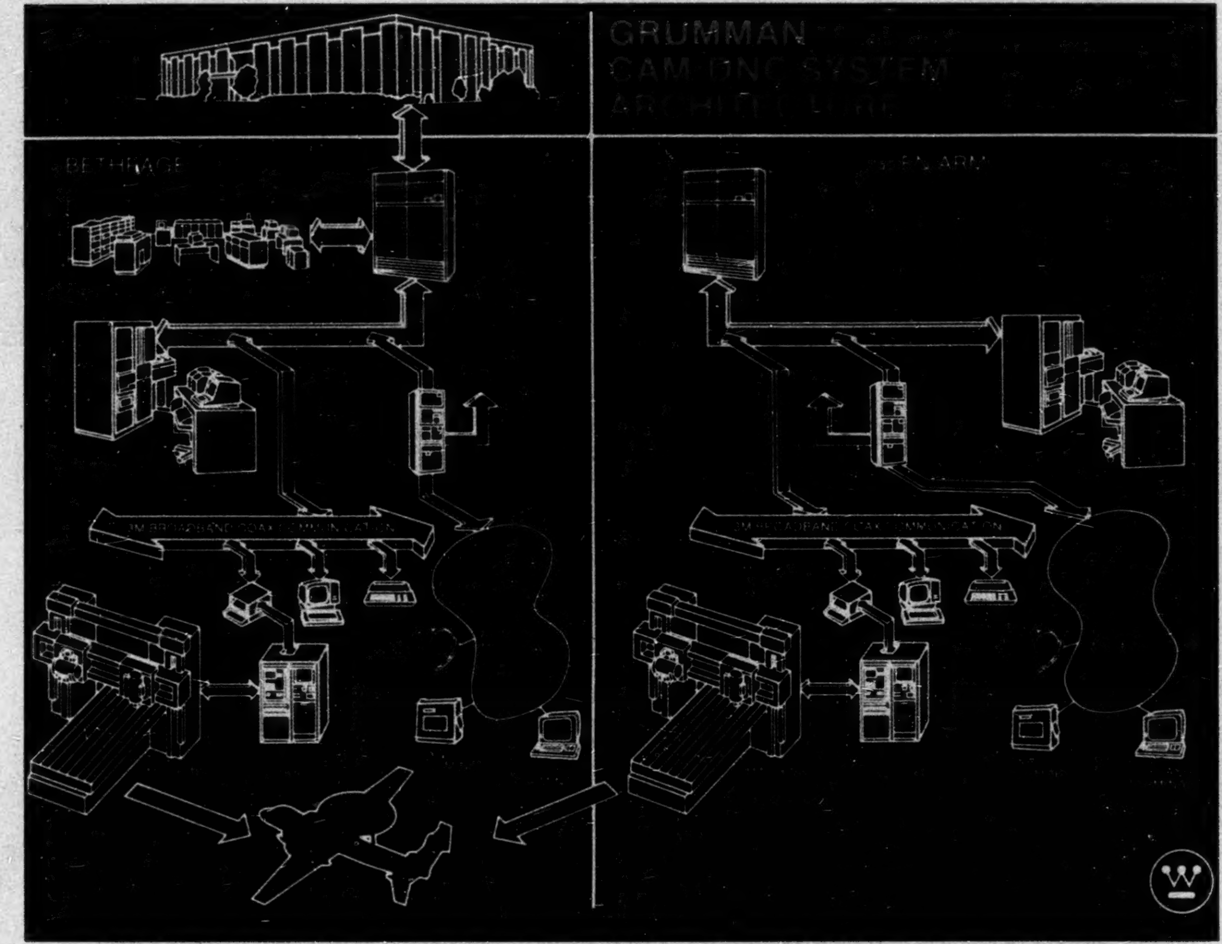
IBM's new series/1 MAP Application Server and series/1 MAP Communications server programs support the integration of plant floor automation equipment into a single network. They allow information to be shared with a variety of automation devices, including plant floor computers, programmable controllers and robotic systems from different manufacturers. The plant host computer also can receive information about the status of work being done.

MAP/One Product Offering


MM-400
Multibus I/O
Head-End Remodulator
MV-400
VMEbus I/O
MP-400
PC I/O
Network Management Console
MG-400
Custom I/O
Network Monitor Software
Network Traffic Analyzer Software
Connection to
• Robotics
• Programmable Controllers
• Materials Handling
• Test Equipment
• Machine Tools
• Process Control
• Machine Vision
• CAD

Source: INI

INI has been selected as the sole vendor on the GMT 400 project. GMT will integragated millions of lines of code between hundreds of devices interfaced over 10 miles of cable. The magnitude of this contract and the number of diverse development agreements between INI and other vendors has the potential to commercialize an "almost-MAP-byproduct".


GRUMMAN
CAM DNC SYSTEM
ARCHITECTURE
BETHPAGE
GLEN ARM
3M BROADBAND COAX COMMUNICATION
3M BROADBAND COAX COMMUNICATION

Grumman Aerospace Corp. Bethpage N.Y. is installing its first MAP compatible proprietary broadband network. The network will integrate two facilities, Bethpage and Glen Arm, Md., via PBX with the host computer residing in Bethpage. More than 78 machining devices, 100 CRT's and peripheral devices will reside on the network.

Grumman Aerospace Corp, Bethpage, N.Y. is installing its first MAP-compatible proprietary broad-band network (3M/LAN1, sold to Allen Bradley late 1985). Westinghouse Electric Corp., Pittsburgh, Pa., is prime contractor and "total systems integrator with responsibility for hardware and software," according to Stan Serota, project manager. The network is scheduled for production by mid-1986.

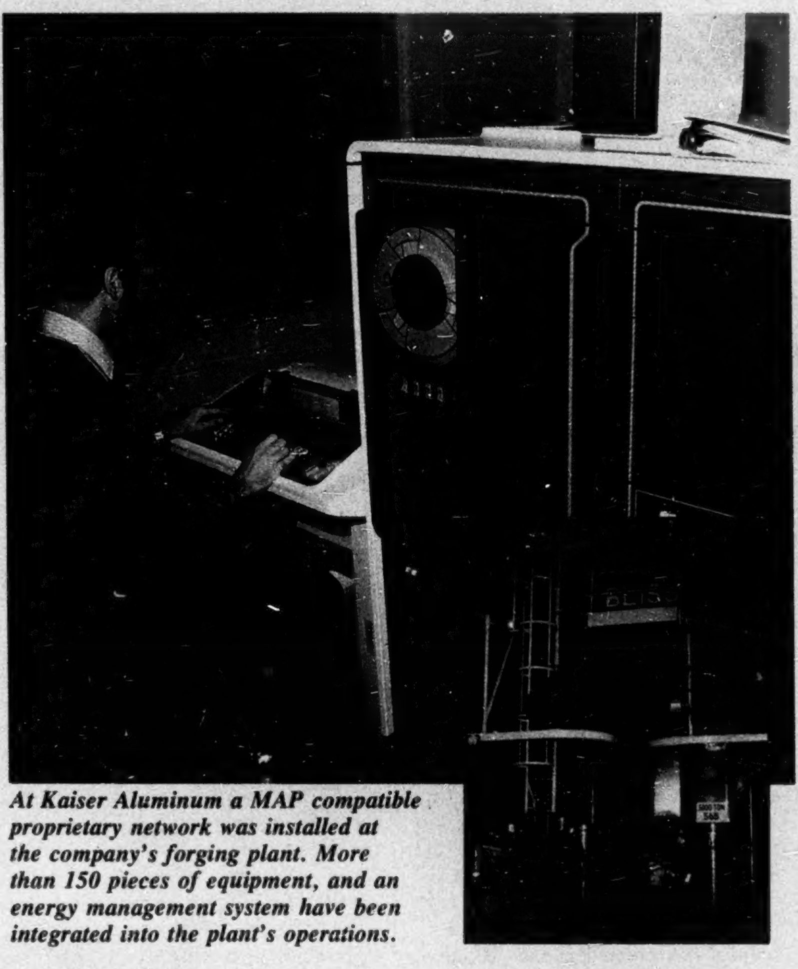
This network will integrate two facilities, Bethpage and Glen Arm, Md., via PBX, with the host computer residing in Bethpage. Each facility has installed complete duplicate or "mirror" systems, from mainframe to cable, "for security reasons," Mr. Serota explained. More than 78 machining devices, 100 CRT's and sundry peripheral devices will reside on the network.

Equipment costs have reached "tens of millions of dollars," said Mr. Serota, "but we predict return-on-investment (ROI) within two years." The ability to quickly turn around prototypes, flexibility in small-lot manufacture, guaranteed consistency in production and ease of modification are just a few of the benefits that Grumman expects to translate into reduced manufacturing costs.

IBM Corp. has chosen its Endicott, N.Y. facility as the site of its first MAP implementation. Still in the early design phase, the network will be used to monitor process, rather than assembly, operations. It is scheduled to be operational in 1987.

Vendors

Twenty-one vendors participated in the MAP demonstration jointly sponsored by GM and Boeing during AUTOFACT'85. They were: Advanced Computer Communications, Allen-Bradley, ACDS, ASEA, AT&T, Charles River Data Systems, Computervision, Concord Data Systems, Digital Equipment Corp., Gould, Hewlett-Packard, Honeywell, Industrial Networking Inc. (INI), Intel, Intergraph, IBM, Motorola, NCR, Northern Tele-



At Kaiser Aluminum a MAP compatible proprietary network was installed at the company's forging plant. More than 150 pieces of equipment, and an energy management system have been integrated into the plant's operations.

com, Siemens and Sun Microsystems.

The testbed demonstration was a success. It also, demonstrated the weaknesses of the MAP specification. The (AUTOFACT) demonstration forced the ambiguities, and the differences in interpretation," said Hewlett-Packard's Paul Accompo, MAP product manager. "Now that vendors have reached a level of conformance, they will be able to work on products," he explained.

But only to a point. The MAP specification is not yet stable, nor is it complete. "Vendors are in a ticklish situation. Each must be the first to market without investing huge amounts for temporary implementations," explained Deere's Dave Scott.

At Honeywell "we hesitate to distribute AUTOFACT software—it's not yet product. The upper-layer FTAM spec was still in a draft form at the time. It was unclear and subject to interpretation. There is a major effort underway to correct the MAP 2.1 errata which may appear in V.2.2 or V.3.0. As a result, true MAP 2.1 product probably won't be available till summer 1986," according to Greg Morris, manager MAP program and Jeff Marks, consulting engineer, Phoenix, Ariz.

The result is a classic "Catch-22". Potential users have little to implement, vendors have a limited data from which to build new, or enhanced, product.

MAP is at a critical point in its evolution. GM's task is further development of the specification. Clearly, it is not responsible, nor in the position, to make the specification work. That task falls to the vendors. Yet the vendors still must contend with a moving target while sustaining criticism for offering proprietary solutions.

By the January 1986 MAP Users Group Meeting in Toronto, more than 260 vendors had expressed intent to support the MAP specification. Joint development agreements between and among vendors are being announced almost daily.

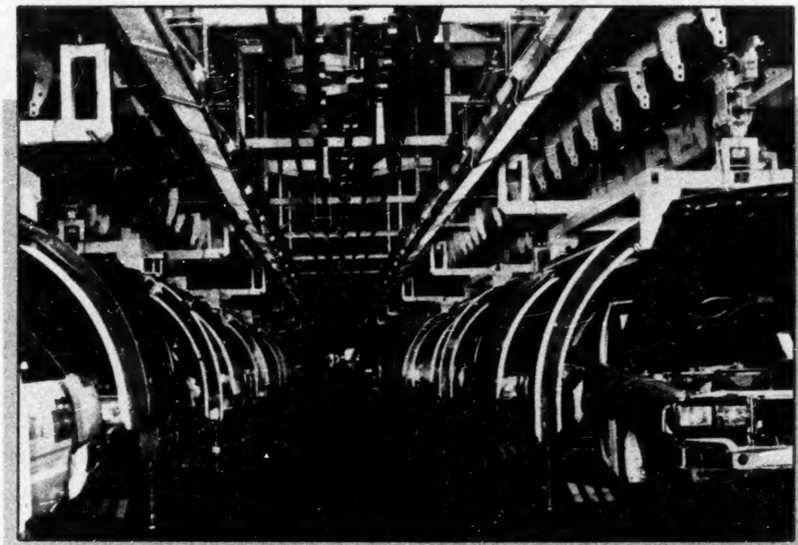
"It's in everybody's interest to have MAP work," said Tony Helies, president of Concord Data Systems, "not demonstrating interoperability is stupid."

But if the MAP effort is to continue its momentum, it's time to make it real. At the SAE Congress and Exposition, February 1986, a morning technical session devoted to MAP was attended by fewer than 25 persons. Show attendance was in excess of 30,000.

"Today, there are other things that will accomplish the same thing," said Kevin Hughes, MAP director at Allen-Bradley, Highland Heights, Ohio. "They may have their drawbacks and limitations, but companies are able to make product."

This year must see actual implementation, of a concerted effort of MAP-complaint equipment. "The market is divided between the early adopters and GM. The future market is dependent upon the results of 1986, the stability of the technology, in order to avoid the proliferation of a single communication solution," said Leonard Magnuson, marketing manager OEM communications, Intel.

There is concern among vendors *and* users that situation may be redeveloping. INI has been selected by GM as the sole vendor on its GMT 400 project. With the MAP document V.2.1 not yet finalized, and with no means of assuring consistent interpretation and implementation, the magnitude of this contract and the number of diverse development agreements between INI and other vendors has the



The concept of MAP is not only being applied and implemented in the U.S. Other companies and countries are moving ahead with how the technology can fit into the European manufacturing landscape. One company, Siemens of West Germany has joined the list growing of MAP vendors. Siemens, like other companies in Europe is interested in the impact of MAP will have on its programmable controller business. In this photo programmable controllers are used to monitor each stage of car body assembly.

Need to Understand MAP? Here's Who Can Help

Support is available from a growing number of suppliers. Ship Star Associates, Newark, Del., offers a series of seminars which cover topics such as business aspects, status and products, OSI concepts, protocols and standards, specifications and futures, implementation issues and network management. Robert Crowder, president of Ship Star, is the founding vice-chairman for standards and chairman for control standards of the MAP Users Group and chairman of the ISA Proway and IEEE 802 fiber optic token bus committees. He is also involved with the ANSI upper layer OSI committee and the NBS/OSI implementors workshop.

Integrated Automation offers support with the management task of integrating the factory. Contact Glen Yeager in Pontiac, Mich.

The Society of Manufacturing Engineers, which was appointed secretariat of the MAP Users Group, offers a variety of support material through the MAP User Group of the SME. Contact Mark Shaw, Dearborn Mich. for membership details and specifics on MAP support services.

GM intends to develop an implementation guide after completion of the Saginaw and GMT 400 projects for internal use, according to Mike Kaminski. It may migrate to the public domain.

EDS will be available to transfer its expertise after the technology is implemented at GM on a consultancy basis, according to Mark Cocroft.

In Canada, support is offered by the Canadian MAP Interest Group (CMIG). Contact the secretariat, the Canadian Standards Association in Rexdale, Ontario.

In Europe, Siemens is spearheading a drive to integrate manufacturing with a worldwide standard. The company is working with INI and the Fraunhoffer Institute in West Germany to develop a conformance testbed. The European Economic Community has created a new initiative under its ESPRIT program, known as Communication Network Manufacturing Applications (CNMA) in order to introduce MAP protocols within the European computer, automation and automotive industries. The Cranfield Institute of Technology, Bedforshire, England, has been named the European Map Users Group (EMUG) secretariat. At the CIM Center commissioned by IBM, R&D efforts and training programs are available to EMUG's 180 members. Texas Instruments is working with Cranfield on network and machine tool interface devices for universal machine connectivity.

For information on the Japanese and Australian MAP Users Group, contact the MAP Users Group secretariat, SME, in Dearborn, Mich.

Other Activities

The Technical and Office Protocol (TOP) is a specification document, also based on the OSI concept, initiated by Boeing for use in technical and office environments. Publicly released at AUTOFACT '85, it is completely MAP compatible, enabling information to move between office and factory environments. The basic difference is the implementation of baseband cable, which, according to Laurie Bride, manager networking technology at Boeing Computer Services, is specified because office environments typically don't require the attributes of broadband (distance, token passing). In March 1986 the MAP Users Group formally combined the efforts of the two groups into the MAP/TOP Users Group.

Over the past five years, the Air Force has developed its own approach to a communications solution, the Integrated Information Support System (I^2S^2). Working closely with GM and Boeing, I^2S^2 is fully MAP-compatible and will be supplanted by MAP protocols as they are stabilized. The Air Force Logistics Center is in the process of developing an official policy for use of MAP/TOP as part of its modernization program.

potential to commercialize in "almost-MAP-byproduct".

GMT 400 will integrate *millions* of lines of code between *hundreds* of devices interfaced over *10 miles* of cable, according to Joe Schoenebeck, president, INI.

Conformance

In 1984, the Network Evaluation and Test Center (NETC) was established at the Industrial Technology Institute (ITI), Ann Arbor, Mich., as an independant MAP test center.

Work there, and at the National Bureau of Standards, is feverishly underway to establish standard tests for functionality, interoperability and reliability. However, standard tests must evolve from a standard specification. That is a criteria which MAP cannot yet fulfill.

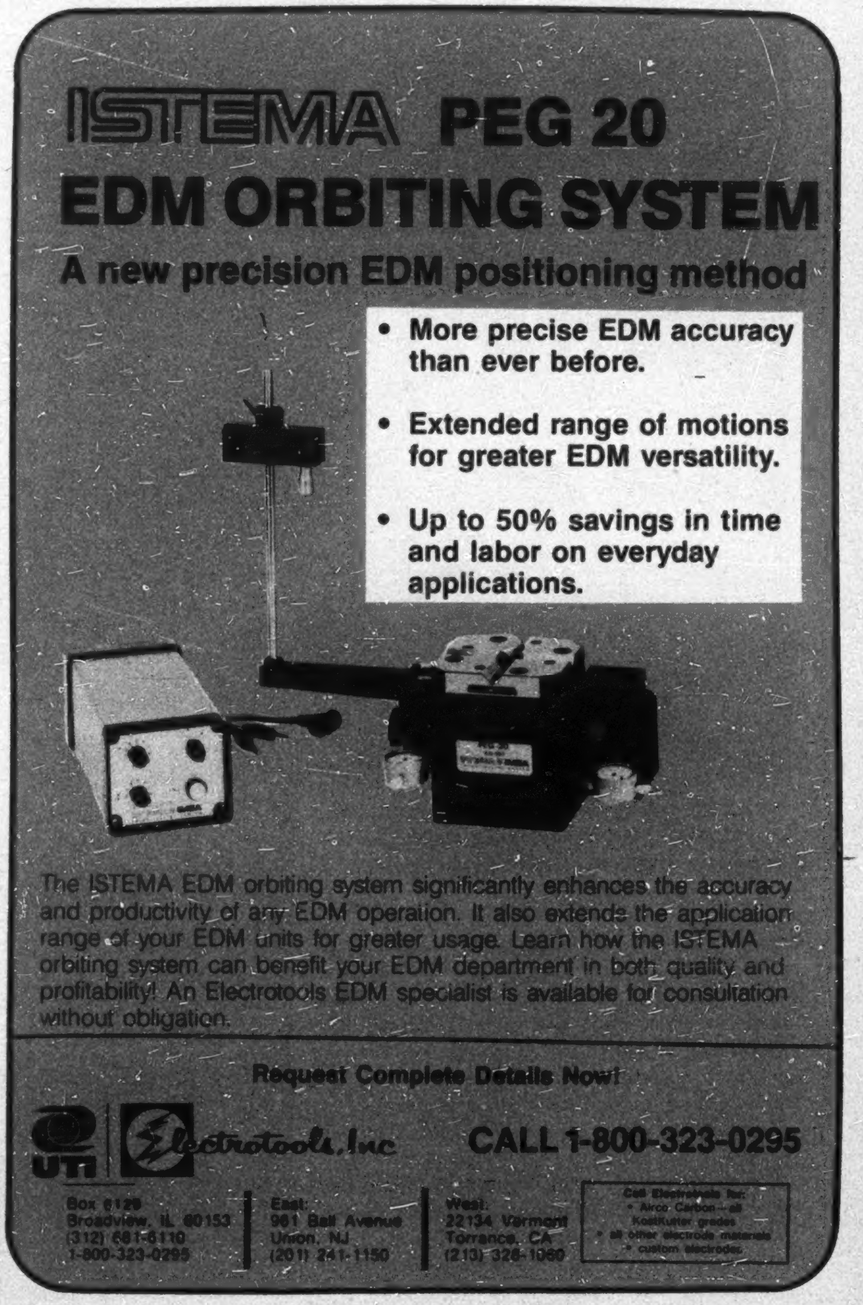
A number of vendors have "tested" interoperability. However, the best case testing is limited to the lower layers of the OSI model and only between two products at a time. In other words, if product 'A' can communicate with product 'B,' and if product 'B' can communicate with product 'C,' it *does not* follow that product A can communicate with product C.

A newly-formed non-profit organization, the Corporation for Open Systems (COS), Washington D.C., plans to develop test and certification methods, in addition to working for industry standards. Member companies include: AT&T, Bell Communications Research (BELCORG), Control Data Corp., Convergent Technologies, Digital Equipment Corp., Harris, Hewlett-Packard, Honeywell, IBM, Intel, NCR, National Semiconductor, Perkin-Elmer, Prime Computer, Sperry, Telex, Tandem, Wang and Xerox.

Will an actual "MAP" emerge? Undoubtedly. The magnitude of the new industry which that movement has generated guarantees the development of a communication solution. The net result, however, remains to be seen.

Nevertheless, the consensus among both vendors and users lies with the implementation of broadband networks. It's multi-media capabilities will support virtually anything.

Success will be a function of planning. Detail each aspect of what is it you hope to accomplish with a network, study the existing information flow, draw upon the implementation experience of documented users, and plan for requirements 10 years out. 🄿



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Here's a Plan That Makes Sense

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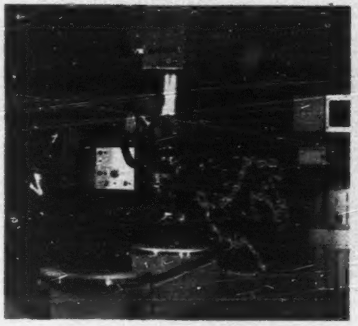

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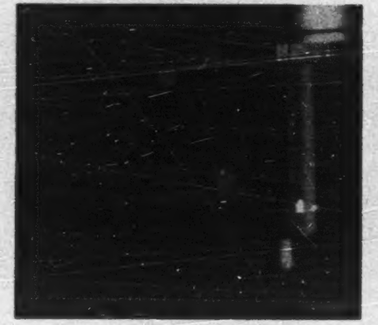

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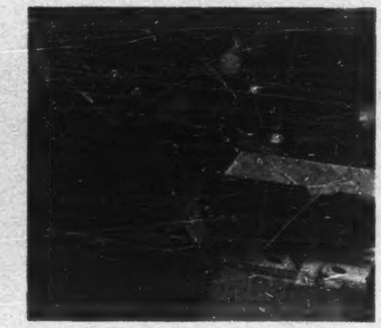

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**Cover photograph showing the abrasive waterjet cutting process was provided courtesy of Flow Systems Inc.*

Statistical Highlights[1]
U.S. Iron and Steel Industry

		1980	1981	1982	1983	1984
Production (millions of net tons)	Total U.S. Pig Iron	68.7	73.6	43.3	48.7	51.9
	Total U.S. Raw Steel	111.8	120.8	74.6	84.6	92.5
	Open Hearth	13.0	13.5	6.1	6.0	8.3
	Electric	31.2	34.1	23.2	26.6	31.4
	Total Canadian Raw Steel	17.5	16.1	13.0	14.0	16.1
	Total World Raw Steel	790.4	779.4	710.7	730.9	782.2
Shipments (millions of net tons)	Total Steel Mill Products	83.9	88.5	61.6	67.6	73.7
	Carbon	73.4	76.6	53.9	60.3	65.0
	Alloy	9.4	10.7	6.7	6.2	7.5
	Stainless	1.1	1.2	0.9	1.1	1.2
Shipments, Major Products, All Grades (millions of net tons)	Shapes, Plates and Piling	13.3	12.7	7.7	7.4	8.5
	Bars and Tool Steel	13.3	14.7	10.8	11.7	13.2
	Pipe and Tubing	9.1	10.3	5.0	3.2	4.3
	Wire and Wire Products	1.8	1.8	1.3	1.4	1.2
	Tin Mill Products	5.7	4.9	4.3	4.3	4.1
	Sheets and Strip	33.6	36.9	27.9	34.8	38.8
Foreign Trade (millions of net tons)	Imports, All Steel Mill Products	15.5	19.9	16.7	17.1	26.2
	Carbon	14.8	18.6	15.4	16.3	24.9
	Alloy	.559	1.1	1.1	.537	.987
	Stainless	.153	.191	.203	.190	.263

(1) With the exception of imports, statistics are compiled from data submitted by reporting companies. However the number of companies participating in the submission of individual statistics varies. For example, raw steel production data are based on reports to AISI from those companies that produce 100 percent of the industry total while the comparable average in the financial statistics is about 80 percent.

Source: American Iron and Steel Institute

Specialty Steel Association Raps Import Surge

"So much for the good will of our trading partners," exclaimed the head of the nation's largest producer of specialty steel as he protested the surge of specialty steel imports prior to the start of March 1 restraints.

Richard P. Simmons, chairman of Allegheny Ludlum Steel Corp., Pittsburgh and also chairman of the industry's trade association, charged that the European Community (E.C.) was "cramming every possible ton of stainless steel into the U.S. before the import-restraint arrangement began March 1." Simmons' protest came as figures for January and February specialty steel imports were made available.

Trade quotas were to take effect January 1, but Simmons, also head of Specialty Steel Industry of the United States, said an agreement was delayed until March 1 "because of intransigence by the E.C."

February imports of stainless sheet and strip from the E.C. leaped 241 pct to 13,025 tons, up from 3,820 tons in 1985. For the first two months of this year, imports for the same products were up 198 pct to 26,761 tons, compared with 8,988 tons in the prior year period.

Stainless sheet and strip shipments from all nations for the first two months were up 139 pct, 39,391 tons vs. 16,454 tons in the like period last year. Total foreign stainless plate shipments to the U.S. were 4,739 tons, up 309 pct; E.C. stainless plate shipments to the U.S. were 4,126 tons, up 489 pct from last year's January-February period.

"The results of these soaring imports in the early months is that E.C. penetration will not be anywhere near the negotiated 3.99 pct on stainless sheet and strip, but more like 16 pct, all because of the delay in implementation," Mr. Simmons stated.

In nearly all the import-restraint agreements negotiated by the U.S. with foreign nations, including the nine-nation E.C., flatrolled stainless products are covered. Flatrolled stainless represents 75 pct of the U.S. specialty industry's production.

In most agreements, however, flatrolled stainless is only a small part of the larger carbon and alloy steel categories. This gives foreign producers an incentive to ship higher-value products rather than the lower-value carbon steel products to fill quotas. This is called "upgrading."

"Upgrading is exactly what has been happening and what is likely to continue without great vigilence and stiffening of resistance in the (U.S.) Administration," said Mr. Simmons.

U.S. Steel Chairman Backs Restraints

As America's specialty steel industry attacked the two-month delay in instituting specialty steel import restraints, the chairman of the nation's largest steel producer praised President Reagan's steel import restraint program.

David M. Roderick, U.S. Steel Corp. chairman, told a hearing of the U.S. House Subcommittee on Commerce, Consumer and Monetary Affairs in Pittsburgh that if the controls "were not in place, many steel companies now described as being under a cloud would instead have been under a statute called Chapter 11."

However, Mr. Roderick stated that the U.S. program, intended to limit importation of foreign steel to one-fifth of the U.S. market, won't prevent shrinkage in an already diminished steel industry.

Mr. Roderick said U.S. Steel is considering buying semifinished steel from domestic competitors to supply the company's finishing mill, the Fairless Works, near Philadelphia.

Lynn Williams, president of the United Steelworkers of America, however, expressed frustration over the loss during the past 10 years of 170,000 steelworkers' jobs. Citing a Congressional research study, Williams showed that trade quotas had saved the jobs of 7,800 workers who produce 3 million tons of steel a year. But the program also allowed nearly an equal amount of steel into the U.S. and eliminated about as many jobs as were saved.

"You can understand, Mr. Chairman, why the United Steelworkers feels that the President's program is not working," Mr. Williams told the subcommittee. "Why were we allowed to be hit so badly by unfair imports in the first place? No amount of relief will compensate for the injury received.

Specialty steel accounts for only about 10 pct of the steel industry's total dollar volume.

Machine Tool Orders Rise Slightly

James A. Gray

workers without giving them the tools to amplify their output. We failed to make the investment that makes them worth their wages, and the result has been low productivity growth and a loss of industrial competitiveness," he said.

Mr. Gray said that although there are many reasons why capital costs more in the U.S., the President's Commission on Industrial Competitiveness "believes that taxes are a major factor...and that the federal deficits are sucking up private sector savings, depriving industry of capital and driving up its costs."

"Business bashing has become a popular Washington sport," added Mr. Gray, "Washington's fiscal actions are built on a foundation of fairy tales that have pushed reality out of the political arena. Even worse, it's the fairy tales that keep many Americans from understanding the folly of current Congressional thinking.

"The new policies we select must be designed to make our market forces work better—not to impede them," Mr. Gray continued. "Congress cannot legislate success; only the cost and the quality of a product can do that. But Congress can select policies that affect the environment in which industry operates—policies that create a climate where investment, creativity and entrepreneurship will flourish. Congress must select policies that keep America continually engaged in the process of creating real wealth so that our citizens can prosper," he said.

March orders for new machine tools rose a slight 2.1 pct over February to $214 million. However, compared to March of last year, orders were off 23.1 pct., according to statistics released by the National Machine Tool Builders' Association (NMTBA).

At $615 million, year-to-date new order figures were down 15.4 pct compared to the first quarter of 1985.

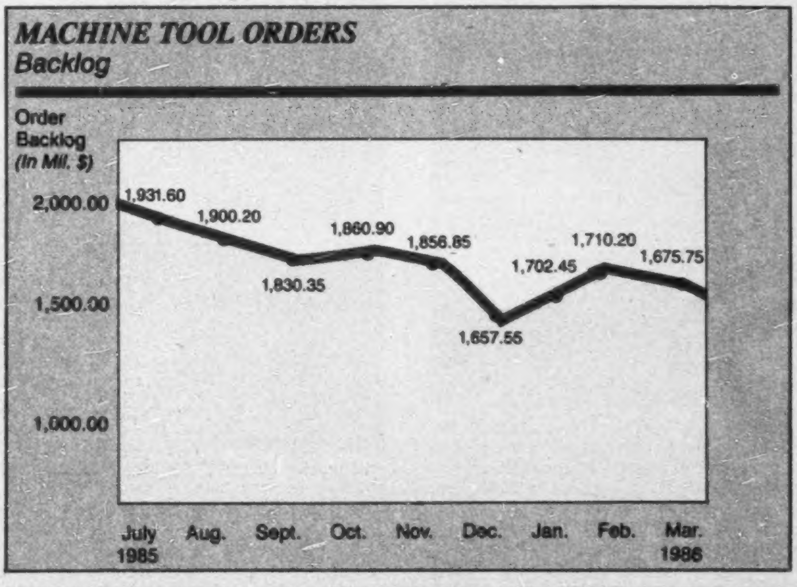
"The continuing sluggishness in the new order picture is a serious concern to us," said James A. Gray, president of the NMTBA. "America's manufacturing industries have taken their lumps over the past 10 years because of the high value of the dollar, and the machine tool industry has suffered along with them," he added.

Mr. Gray said that he had hoped to see a rekindling of investment by domestic industry but stressed that the specter of 'tax reform' looms large over manufacturing." "Every day we hear that money is available for capital improvement, but that purchase plans can't be finalized until the tax and economic situation becomes clearer. This Washington wait-and-see attitude is costing our industry dearly," he said.

With net new orders of $55 million, metal forming new orders were up 31.7 pct over February, representing a 5.3 pct increase over March 1985. Shipments of metal forming equipment also showed a 13 pct increase over March of last year. Year-to-date shipments stood at $210 million or about 20 pct above the figure for the same period in 1985.

Metal cutting machine tool orders totaled $159 million for March, a 5.3 pct drop from February's level, and a 29.6 pct drop from March, 1985. Year-to-date figures were off 12.3 pct. Metal cutting shipments rose to $171 million in March, an increase of 38 pct for the month. Year-to-date metal cutting shipments were up 8.4 pct.

With shipments exceeding orders, the preliminary combined metal cutting and metal forming backlog figure of $1.6 million for March represents a drop from the February figure of $1.7 million. At $1.3 million the metal cutting backlog is down from 1.3 million. The metal forming backlog stands at $356 million, down from $378 million a month ago.



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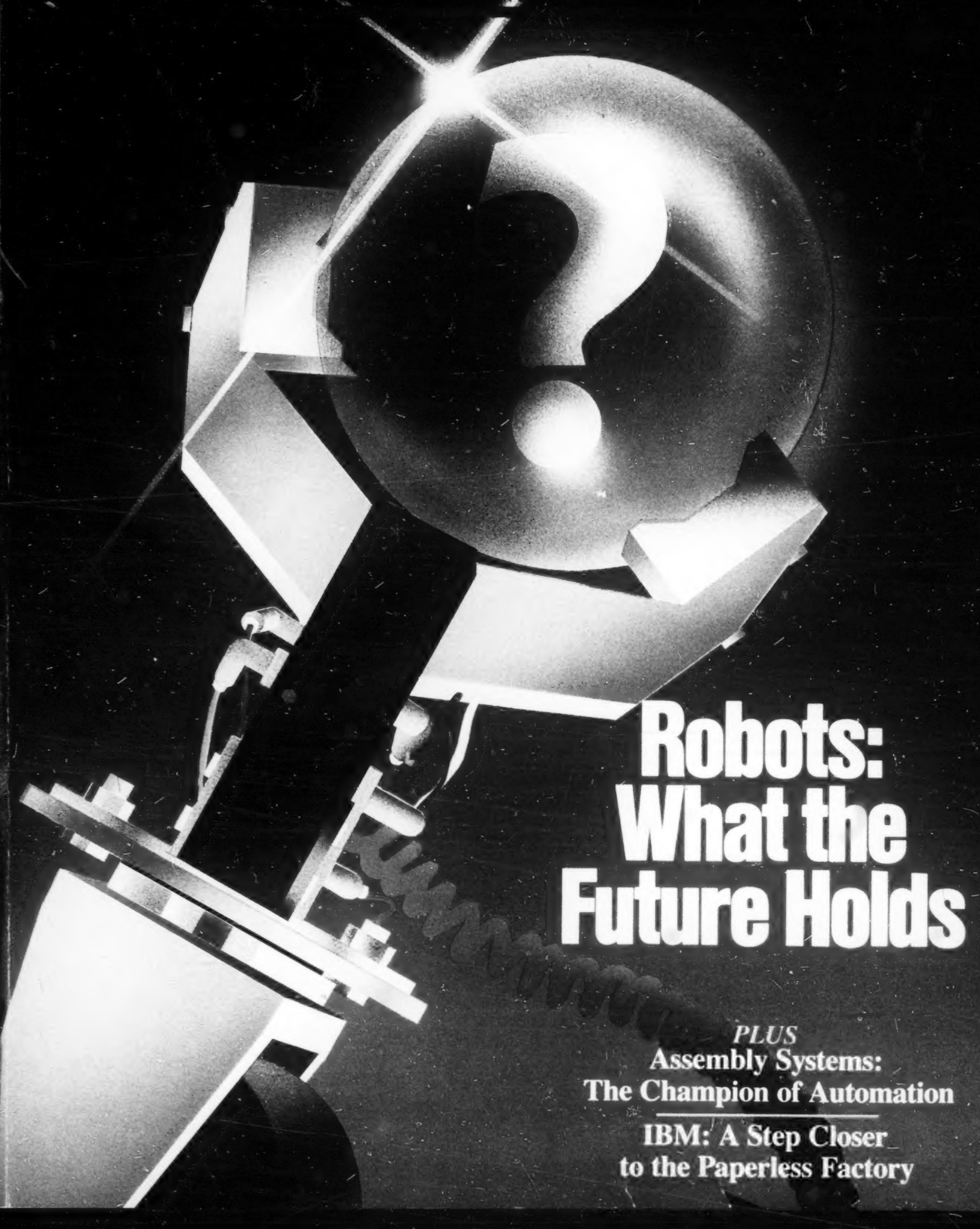

Robots: What the Future Holds

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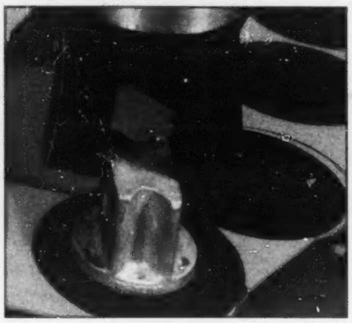

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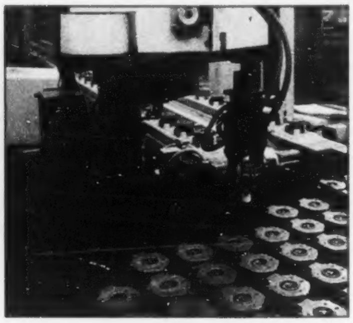

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it three years ago, at least 25 pct of the then-existing U.S. machine tool companies have either gone out of business, have been bought up by other interests, or have moved their operations offshore. The President's response should help stem this precipitous deterioration and thereby strengthen the national security." Mr. Gray said.

"Although the last few years have been especially trying for those companies that design and build machine tools, we have not been idle as the Administration studied the case. American builders recognize that they hold the key to their own future.

"For an industry that has not made any money since 1982, their commitment to research and development has been admirable. As a result, 75 pct of today's orders are for machine tools that embody technology not available in 1980.

"Moreover, the industry and key users are today working to establish a National Center for Manufacturing Sciences to conduct generic research and development.

"The recovery of our industry has been and will continue to be impeded by the fact that President Reagan was prevented by certain members of his own staff from even considering our petition for over two years.

"Those staff members, for reasons known only to themselves, refused to allow the recommendations of the Secretaries of Commerce and Defense on our petition to reach the President. Their inaction contributed significantly to the weakening of the very national security interests that they are charged with protecting.

"We believe that, as Congress develops comprehensive trade legislation this year, it ought to impose a deadline on the presidential decision-making process as it applies to Section 232 (National Security Clause) decisions, to prevent those involved in the process from causing similar damage to America's national security interests in the future.

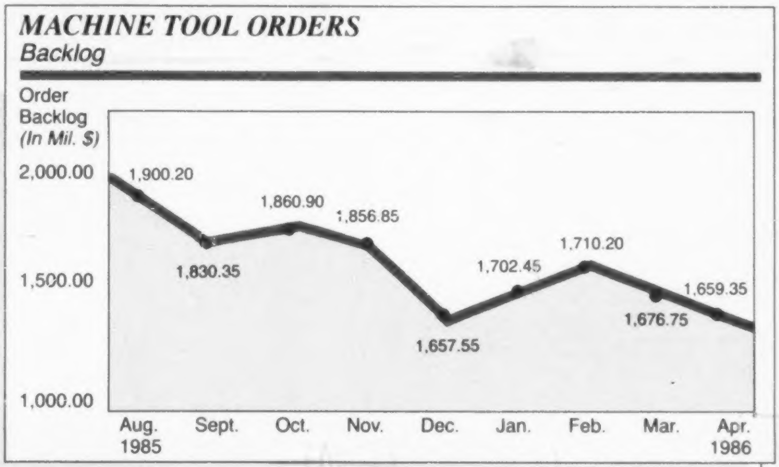
"We in the machine tool industry are proud of our historic role in providing the industrial muscle for America's national security and industrial development. We see the President's decision as an opportunity to build upon our record of service to the nation."

After a year's internal study of the problem, the machine tool industry's petition was initiated by NMTBA in March 1983 under Section 232, the National Security Clause, of the Trade Act of 1962. This requires the president to adjust imports of vital defense-related items if those imports threaten the national security.

Machine tool imports in 1985 accounted for about 41 pct of the value of the domestic market, up from 34 pct in 1983 when NMTBA filed its 232 petition.

Net new orders for American-made machine tools have declined from $4.8 billion in 1980 to $2.5 billion in 1985.

"We are delighted that the President has finally recognized how vital the machine tool industry is to our defense efforts."



Machine Tool Orders Down in April

New machine tool orders for April fell to $193.45 million, down to 9.9 pct from the $214.60 million posted in March, according to the National Machine Tool Builders' Association (NMTBA).

Orders for metal cutting machinery fell 14.8 pct to $136.25 million from $159.90 million. Metal forming orders rose 4.6 pct to $57.20 million from 54.70 million.

Comparing April 1986 to April 1985, metal cutting orders rose 11.6 pct while metal forming orders fell 6.8 pct, resulting in a net order gain of 5.4 pct over the same month a year ago. However, year-to-date figures for 1986 compared to last year showed an across-the-board drop, with metal cutting down 7.8 pct and metal forming down 19.8 pct, resulting in a combined loss of 11.2 pct.

Total cutting and forming shipments fell by 15.6 pct in April, dropping to $210.10. April metal cutting shipments fell to $152.90 million, a 10.9 pct drop. Metal forming shipments fell by 26.0 pct, down to $57.20 million for the month. Year-to-date combined shipments showed a 15.1 pct rise over the same term a year ago, with metal cutting up 17.3 pct and metal forming up 10.9 pct.

Metal cutting backlogs were down to $1.3 million, a drop of $16 million for the month. The metal forming backlog remained the same as in March at $365 million. The April combined metal cutting and metal forming backlog figure has dropped to $1.6 million.

Automakers Increase Use Of P/M

The U.S. automotive industry could increase its usage of powder metallurgy (P/M) parts used in an average car to 40 pounds per car in the not to distant future, according to Kempton H. Roll, executive director of the Metal Powder Industries Federation (MPIF).

The automotive market accounts for 70 pct of the output of P/M parts in North America.

As an example of P/M inroads in cars, the Federation recently gave awards for a high strength, P/M alloy steel-forged internal ring gear, used in GM truck transmissions and a 4600 forged-steel P/M transmission race used in the new Ford Sable and Taurus model cars. The internal ring has a surface tensile strength of 300,000 psi and a tensile strength of 220,000 psi in its core. The Ford automatic transmission race was designed as a P/M forging to obtain improved fatigue.

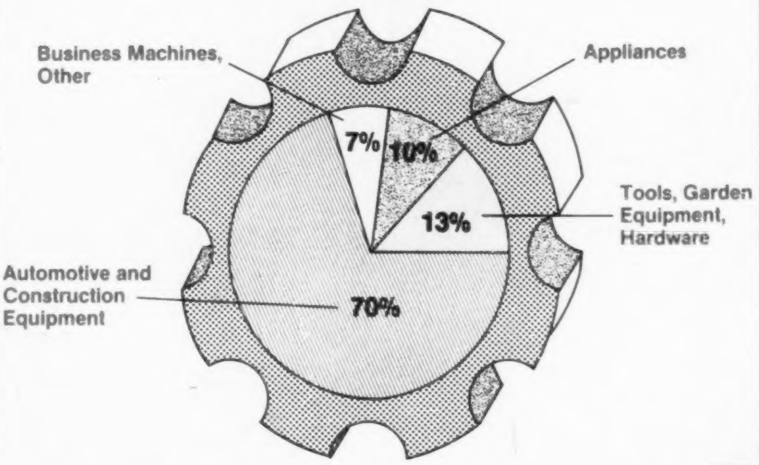
P/M steel forged connecting rods are expected to be used in Ford and GM cars in the 1987 model years.

Markets for P/M parts in appliances are up 10 pct due to increased housing starts. The use of P/M parts in lawnmowers and tractors, power tools, recreational equipment and hardware is growing and represents about 13 pct of the industry's output.

Total metal powder shipments in 1985 declined about 10.5 pct to 269,220 tons. Mr. Roll attributes this to both inventory adjustments and the impact of foreign competition.

–Eastern region reported
by Tom Halligan/Philadelphia

P/M PARTS MARKETS - 1985
(North America)



Includes Bearings and Friction Materials. Custom and In-Plant Production. Based on Tons

Source: Metal Powder Industries Federation
Powder Metallurgy Parts Association

MIDWEST

Chrysler Invests $866M in St. Louis Plants

Chrysler will invest $886-million at its two assembly plants in St. Louis, Mo., which produce the minivan and is slated to produce a new sporty front-wheel-drive mid-specialty car.

Currently the Windsor, Ontario plant is the only facility building the Plymouth Voyager and Dodge Caravan minivans. Since their introduction in 1984, they have been "sold out"—last year the minivans took 51 pct market share. Chrysler has been seeking a second source for over a year and will spend $475-million to make the St. Louis II Assembly Plant that second source. Production is expected to begin next March.

Five new buildings, 500,000 sq. ft. will be added to the facility for minivan production. In addition, state-of-the-art technology will be installed—the number of robots will increase from five to 125 and the number of computers will rise to 847 from 54.

However, Chrysler must now find a new source of production for its large rear-wheel-drive models—the Chrysler Fifth Avenue, Dodge Diplomat and Plymouth Gran Fury—currently assembled at St. Louis II.

At the recent American Motors Corp. shareholders meeting, president and chief executive officer Joseph Cappy said that preliminary discussions were underway with Chrysler to produce those vehicles in the Kenosha, Wisc. AMC facility. However, Chrysler has an underutilized plant in Brampton, Ontario which could be retooled for M-body production.

The St. Louis I plant is slated for a $391-million face-lift to gear up for production of a "brand new, super sporty mid-specialty car" to be introduced in October. The plant will be expanded by more than 130,000 sq. ft. and technology will be upgraded to 21st century standards—robots increasing to 191 from 70; machine welders to 94 from 82; computerized weld controls more than doubling to 376 from 170.

The new model, a two-door hardtop and convertible version of the LeBaron series, will be integrated into production with the Dodge Daytona and Chrysler Laser currently assembled at the St. Louis I line.

ON THE MANAGEMENT SIDE

Computers in the Board Room–Look But Don't Touch

Senior managers are more likely to review the printout than use the computer.

MORE THAN HALF THE TOP EXECUTIVES of America's largest corporations never use a computer, but more than 64 pct of these executives believe computers "help managers do their job better." The chief executive and chief operating officers of the Fortune 500 companies—821 people in all—surveyed by Kepner-Tregoe, Inc., the Princeton based specialists in human resource consulting and software for managers, were asked a series of questions about current and future computer use in their organizations.

Of the 92 executives who responded, 70.6 pct of them do not have a computer terminal in their office. Only 27 pct do have a terminal within arm's reach.

When asked if they "personally use a computer," 18.5 pct said they use a computer "often," 27 pct use it "sometimes," and 52.2 pct use it "never."

The CEO's and COO's were also asked if they personally review computer printouts. Of the total, 13 pct "never" do; 49 pct review them "sometimes" and 28 pct said "often."

Thus, America's most senior managers are more likely to review computer printouts than to use a computer. This is also reflected in our finding that other top managers, below the CEO-COO level, are more likely to use computers than the CEO's and COO's themselves.

Question: *What percentage of your top management team uses computers?*

Percent of Usage Reported	Percent Responding
0-25	54.9
26-50	24.2
51-75	8.8
76-100	12.1

When the senior executives were asked what they "most frequently use the computer to accomplish," the overwhelming choice was financial analysis. A distant second was word processing. Only one respondent said "planning."

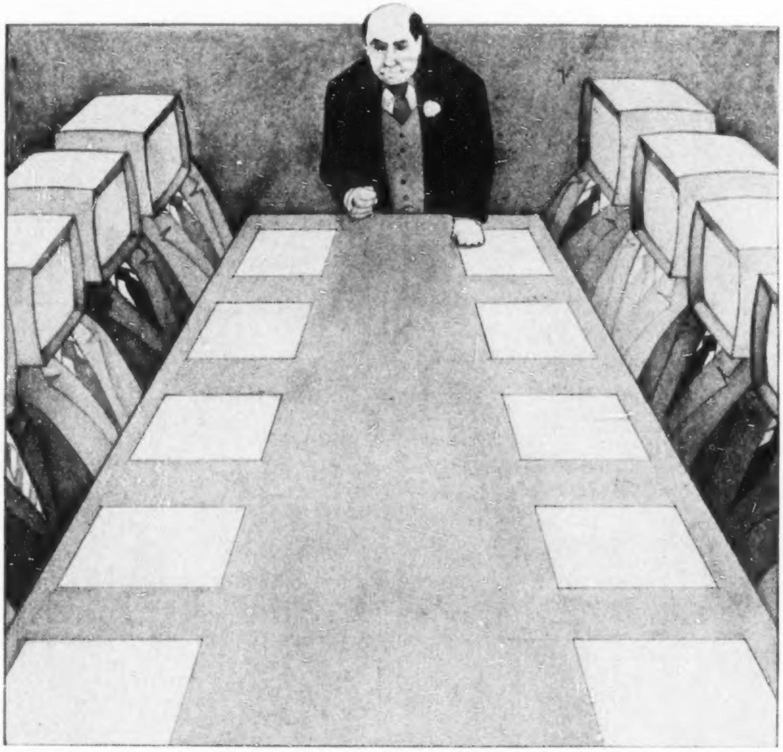


Illustration by Steven R. Cusano

Question: *If you do use a computer, what do you most frequently use the computer to accomplish?*

Answers	Percent Responding
Financial analysis	26.1
Word Processing	7.6
Telecommunication	3.3
Scheduling/calendar	3.3
Market trend analysis	3.3
Margin ratios	3.3
"What if" scenarios	2.2

The senior executives were also asked to identify both the greatest threat and the greatest opportunity posed by the computer. The greatest opportunity, identified by 22.8 pct of respondents, is time saving. The top two threats were a tendency to bog managers down with unnecessary data, mentioned by 12 pct, and the computer as a substitute for thinking which 10.9 pct noted. However, a greater number, 13 pct, said there is no threat at all from using computers.

Question: *What is the greatest* **opportunity** *posed by the computer for your business organization?*

Responses	Percent Responding
Time saved/timely data retrieval	22.8
Production, manufacturing control	11.9
Improved decision making	9.8
Greater accuracy and availability of data	9.8
CAD/CAM modeling	8.7
Increased efficiency/ better organization	7.6
Improved customer service	5.4
Better communication	4.3
Enhance personal productivity	3.3
Manage complex data	3.3
Gain competitive advantage	3.3
Reduce costs	2.2

Question: *What is the biggest* **threat** *posed by the computer for your business organization?*

Responses	Percent Responding
No threat seen	13

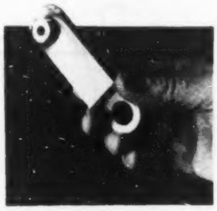
Computers have a long way to go to reach their full potential to improve the way we manage.

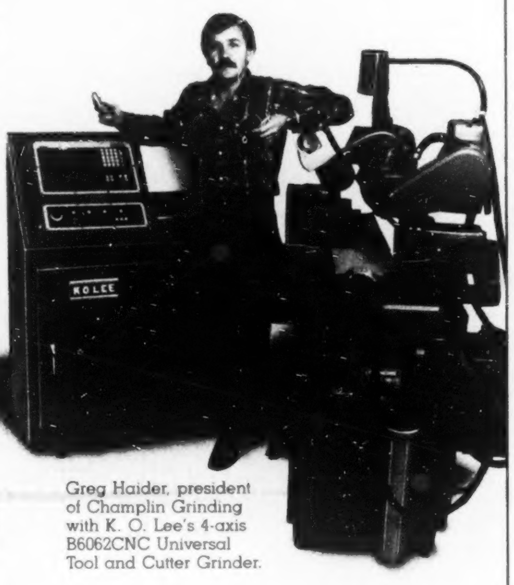
Excess or unnecessary data	12
Substitute for thinking	10.9
High cost	8.9
Security problems	4.3
Inaccurate data	3.2
Poor management of the computer itself	3.2
Digression from work assignments	3.2

The overall reactions to current and future computer use by these CEO's and COO's was positive, but the negative comments surface major hurdles separating computers from increased efficiency.One CEO said, when asked if computers help managers do their jobs better, "No. They are tools for people who do tasks—not managers." (This CEO also indicated that no one in top management in his or her organization uses a computer.) Another response to the same question was, "Middle managers, yes—top management, not yet! Systems capability not available to make computers more effective." A third responded, "Executives are paid too much to develop computer skills at their current level. Executives are being paid to analyze and implement." And a fourth, emphasizing how computers can contribute positively, commented that computers provide an opportunity for "Enhancing personal productivity, just as the telephone did." The implication in all of these remarks is that computers have a long way to go to reach their full potential to improve the way we manage.

Other foreboding views of computers in executive suites include several executives who cautioned against inaccurate data contained in the computer. Still others, typified by one CEO's comment, cautioned against "dehumanization of decision making." Another CEO warned that computers "take judgment out of decisions." "Loss of personal touch with raw data, loss of personal dexterity," was one respondent's somber view. Yet another warned against "Becoming too data bound! There will always be a place for intuitive and creative judgment which can cut through endless analysis." A fear of "conformity—consensus thinking in management" was expressed by a senior exeuctive. In a similar vein, one COO fears "centralization—don't want it."

One of the most curious responses was by a chairman of the board who said computers help managers do their job better, but no one in senior management in his or her company uses a computer! 🅿





/ TOLERANCES I CAN COUNT ON AND REPEATABILITY I CAN RELY ON /

When Greg Haider of Champlin Grinding went looking for the right equipment to start up his Minnesota-based precision grinding corporation he came to K. O. Lee. "I knew I could depend on their tool grinder and CNC control to deliver the close tolerances my customers demand. In many cases that meant holding accuracies on a part to fifty millionths or producing a four micro-finish. And holding that time after time again. I also needed a machine that was versatile enough to handle more than one function. I'm talking I.D. and O.D. grinding and specialty surface and form grinding. For my money, no product compares to K. O. Lee. I'm sold."

Greg Haider, president of Champlin Grinding with K. O. Lee's 4-axis B6062CNC Universal Tool and Cutter Grinder.

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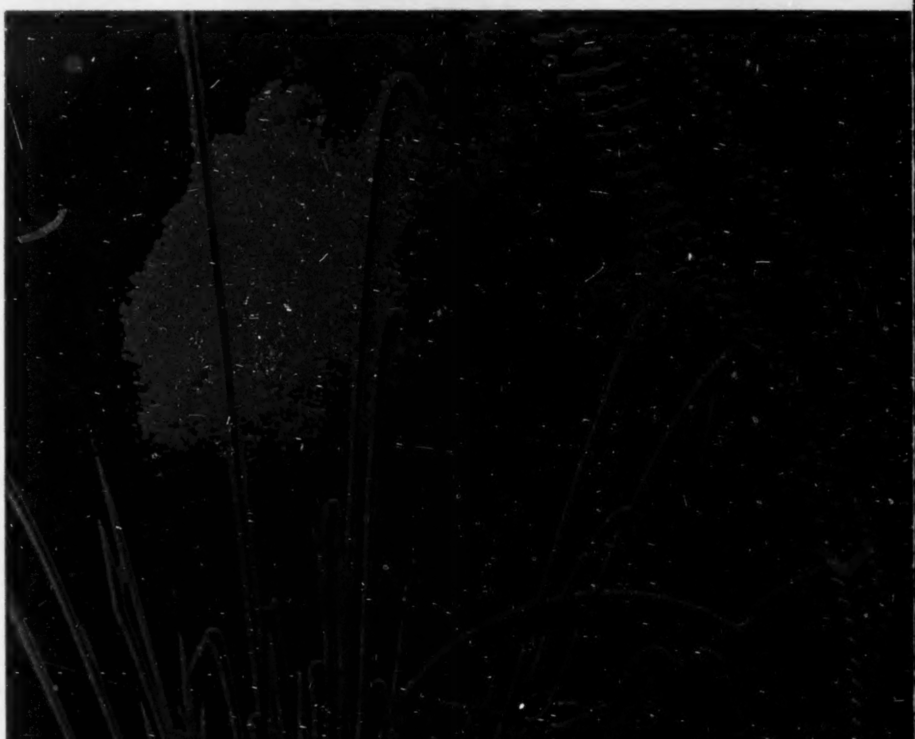
Robots: What the

Today, 25 years following the invention, the industry finds itself in a state of transition.

By Thomas M. Halligan
News Editor



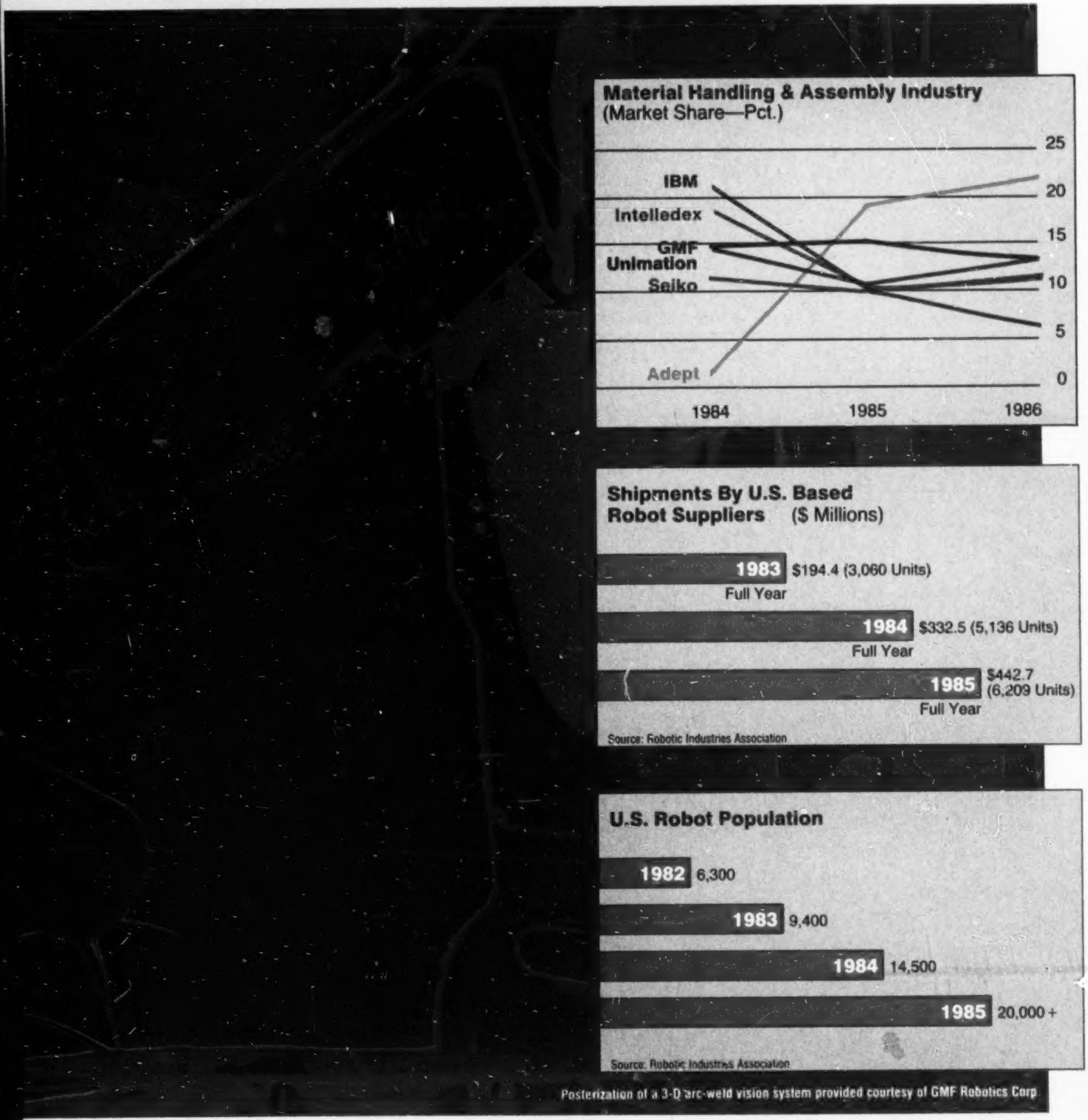
IF YOU LISTENED VERY CAREFULLY during the conferences at the recent Robots 10 exposition, thoroughly read the manufacturers' brochures and the conference proceedings, questioned sales personnel on the display floor, and again during the evening receptions, you would definitely come away confused about the present—and future—state of the robotics industry. And justly so.

Has it leveled-off? Some analysts contend it has. Is it in transition? That's what some manufacturers stressed. Are new markets being sought to supplement the fickle auto industry? Positively, said others. Will vision systems and off-line programming be incorporated into every robot produced in the future? Will there only be a handful of manufacturers within 10 or maybe 5 years? Will prices come down? Go up? What about integration? Well, you get the picture.

Probably no other piece of industrial machinery in the past 25 years has received as much scrutiny as the industrial robot. This is in large part due to the robot being extolled as a replacement for the human factory worker, coupled with the robot's personification depicted in futuristic novels, films and television shows.

But today, some 25 years after Unimation founder Joseph Engelberger constructed the first industrial robot for General Motors, one point is clear: The

Future Holds



Material Handling & Assembly Industry (Market Share—Pct.)

Shipments By U.S. Based Robot Suppliers ($ Millions)

Source: Robotic Industries Association

U.S. Robot Population

Source: Robotic Industries Association

Posterization of a 3-D arc-weld vision system provided courtesy of GMF Robotics Corp.

Percentage Distribution of Robot Sales in the U.S., by Robot Application

	1985	1990	1995
Machine tending	16%	15%	15%
Material transfer (excl. machine tending)	16	15	15
Spot welding	26	15	10
Arc welding	10	10	9
Spray painting/coating	10	10	7
Processing*	5	7	7
Electronics assembly	6	12	14
Other assembly	5	8	12
Inspection	5	7	10
Other	1	1	1
	100%	100%	100%

*Includes such applications as routing, drilling, grinding, etc.

Forecast of Dollar Sales of Robots in the U.S., by Application

	1985		1990		1995	
	Unit Sales	Total $ (mil.)	Unit Sales	Total $ (mil.)	Unit Sales	Total $ (mil.)
Machine Tending	800	28.0	1,650	61.1	2,250	69.8
Material transfer	800	28.8	1,650	62.7	2,250	78.8
Spot welding	1,300	78.0	1,650	95.7	1,500	75.0
Arc welding	500	30.0	1,100	66.0	1,350	78.3
Spray painting	500	30.0	1,100	66.0	1,050	63.0
Processing	250	11.3	770	38.5	1,050	62.0
Electronics assembly	300	10.5	1,320	52.8	2,100	66.4
Other assembly	250	8.8	880	30.8	1,800	63.0
Inspection	250	13.0	770	38.5	1,500	75.0
Other	50	2.0	110	4.2	150	6.0
Totals	5,000	$240.4	11,000	$516.3	15,000	$637.3

Percentage Distribution of Robot Sales in the U.S., by Industry

	1985	1990	1995
Agriculture	1%	1%	1%
Mining and extractive	1	2	2
Construction	0	1	1
Electricity generation	1	1	1
Consumer non-durables	2	5	5
Non-metal primary commodities	2	4	5
Primary metals	3	4	5
Non-metal fabricated commodities	5	6	6
Fabricated metal products	10	8	8
Machinery	8	10	11
Electronics/precision equipment	8	10	16
Automotive	51	38	26
Aerospace	6	6	8
Other transport equipment	2	3	4
	100%*	100%*	100%*

*May not total 100% due to rounding.

*Reprinted courtesy of the Society of Manufacturing Engineers and the University of Michigan from Industrial Robots Forecasts and Trends, copyright 1986.

robotic industry is, indeed, in a state of transition. But this transition stage is one that will catapult the industry into the next decade armed with new generation sophistication, diversification and applications. And too, the robotics industry will penetrate a wide variety of new industries including electronics, the hazardous waste industry, pharmaceuticals, precision equipment, semiconductors, the garment industry and medical applications. Of course, metal-working manufacturing will see the greatest spread of robotics in the future.

Consider the findings excerpted from a recent study conducted by the Society of Manufacturing Engineers in conjunction with the University of Michigan, entitled, Industrial Robots, Forecasts and Trends:

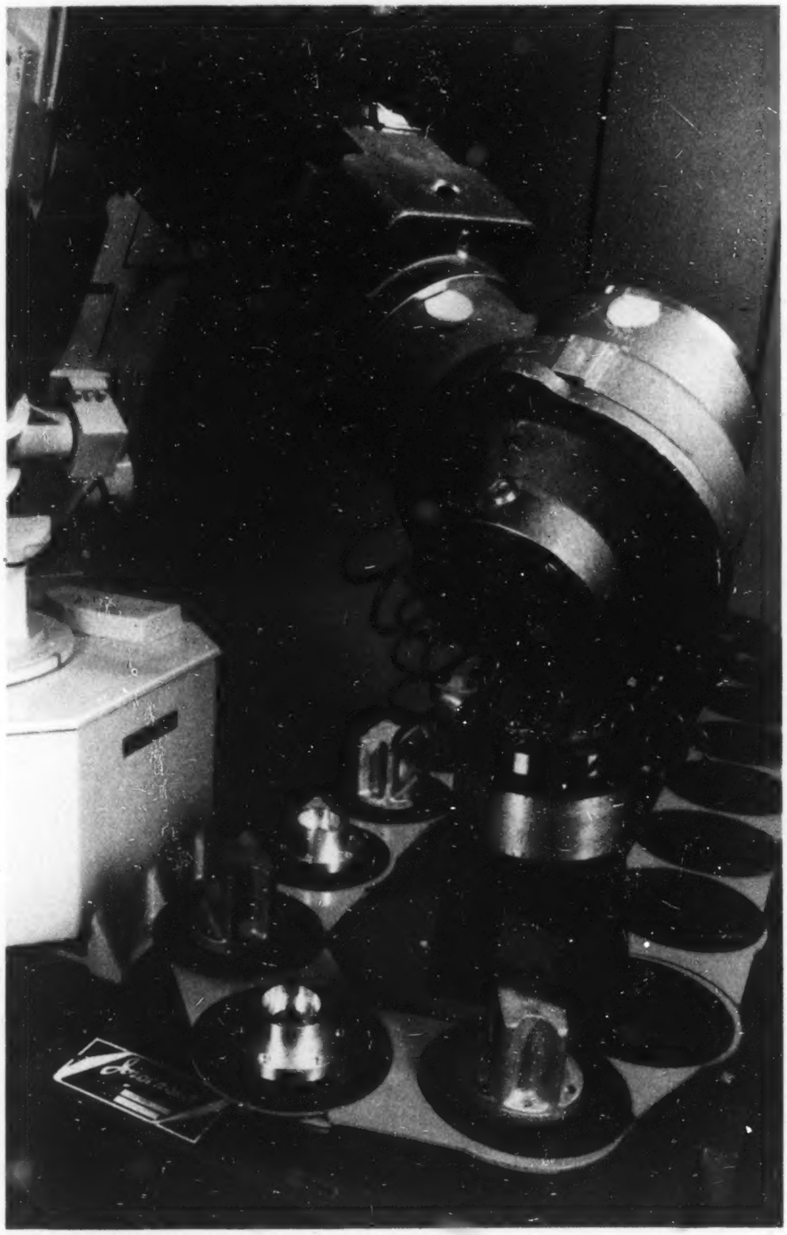
- Actual numbers of robots purchased in the U.S. are expected to increase throughout the decade in all manufacturing classifications. The current leading consumer, the automotive industry, will account for a shrinking share of expanding total sales (51 pct now, 26 pct in 1995), as other industries, particularly electronics and precision equipment producers (8 pct now, 16 pct in 1995) accelerate their pace of robot purchases.
- Industrial robots are forecast to change in appearance, improve in accuracy, and become available in abundant variety. By 1995, for example, 15 pct will have two or more arms, 11 pct will be mounted on ceilings or walls; 21 pct will move along a track; some computer control devices (micro, mini, or mainframe) will direct the movements of 90 pct of all robots; and certain classes of robots will be accurate to ±.0005 inches per second.
- Half of all robots that are controlled by computers are expected to be programmed off-line by 1995; some 40 pct will be debugged by CAD simulation. The odds of a standardized off-line robot programming language being in use during this period was rated 25 pct by those surveyed by the SME.
- Robot leasing and time sharing programming services are projected to

develop into thriving commercial sectors; 15 pct of all robot units will be leased and a similar share programmed by time-sharing in 1995.

- Sensory devices will be utilized by 60 pct of all robots by 1995, according to the forecast. They will be most plentiful on robots devoted to inspection, assembly, and welding tasks. Among robots with some form of sensing capabilities, 25 pct will have machine vision, 25 pct tactile sensors, another 25 pct some kind of sensor (e.g., range proxmity), and the balance will be equipped with two or more sensor types.
- The U.S. manufacturer of robots is expected to create more than 44,500 jobs by 1995. Some 3,000 workers will be employed by robot producers, 4,500 in supplier industries, another 25,000 will perform maintenance in robotized facilities, and about 12,000 programmers will create and maintain robot software.

Overall, the industry as a whole should see an annual growth rate of between 20 and 38 pct, according to projections garnered from various manufacturers, industry analysts and robotic associations. Domestic sales are expected to reach close to the $5 billion mark by 1995. And by the end of the century approximately 165,000 robots will have been installed in the U.S. At present, there are about 20,000 working robots in the U.S. equalling $440 million in sales.

Optimistic? Yes, especially if you consider the present state of the robotics industry. Certainly there are problems. Recent accounts of horror stories by end-users, amplified in the general news media, have caused some manufacturers to cancel robot orders and rethink overall automation plans.



A Cincinnati Milacron T3 786 robot can handle a 200-pound payload but is flexible enough to give 238 degrees of pitch and yaw motion, and 900 degrees of roll motion.

"The problem," remarked Lester V. Ottinger, president, Advanced Manufacturing Systems, "is that we're doing a pretty good job producing sophisticated robots, but we lack in the final implementation. We're not doing a good job launching these things. Automating a factory is like a symphony orchestra. Each section—the horns, strings and percussion, is good by itself, but if they haven't practiced together, they can't make music. We're not using our tools in concert. People are looking for some giant solution to solve the mystery of trying to bring the technologies together...It's common sense...we just haven't practiced enough yet," he said.

"It's not the robot or the equipment that's really expensive, it's the way manufacturers have to change to incorporate the technology," added Jerry Saveriano, president of Saveriano Associates, an automation consulting firm, who has devoted the past 11 years

Next Generation Robots

There are 20,000 working robots in the United States today. By 1995 projections call for approximately 500,000 robots to be at work in a vast array of industries, performing exotic applications.

What will these next generation robots be like? What materials will they be made from? What applications will they perform? And how much will they cost?

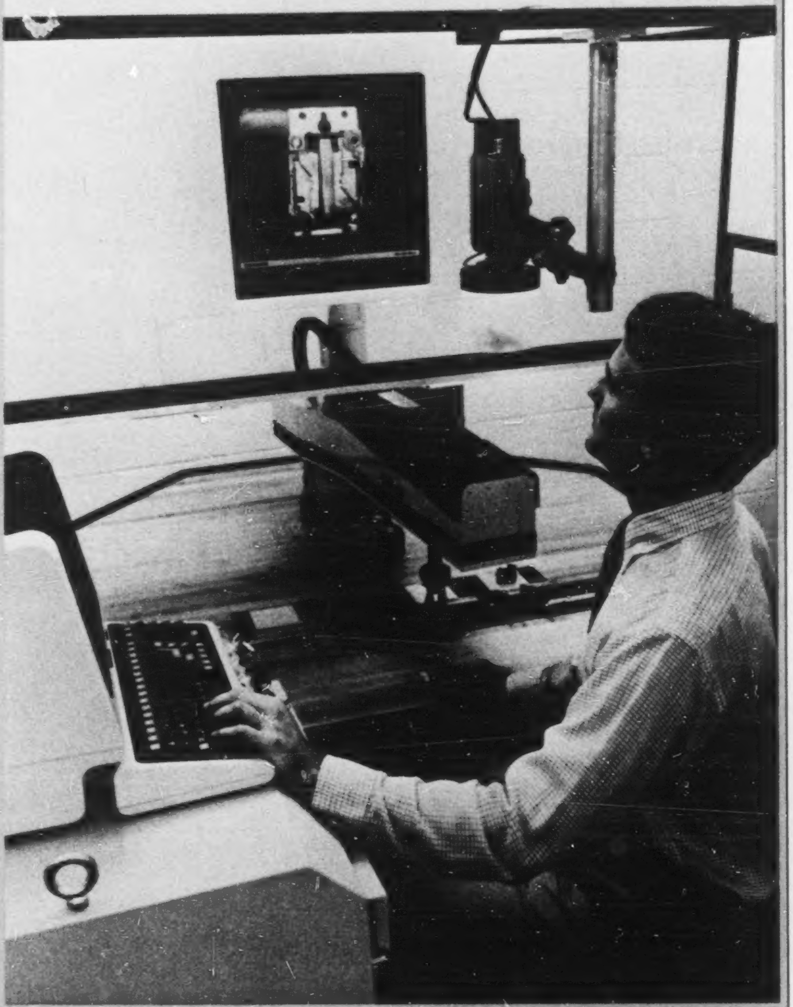
From interviews with industry leaders, and information gathered from reports and forecasts, the following is an overview of the next generation of robots.

Almost everyone in the robotics industry agrees that there will be an increasing use of vision and sensor systems in the next generation of robots. One analyst put it this way, "A robot in the future won't be a robot if it doesn't have vision."

"As we look down the way," said Eric Mittelstadt, president and CEO, GMF Robotics, "there will be the development of smarter robot mechanism that have built-in or integrated intelligence capabilities: vision and sensors and mobility and logic...a growing number of products added onto the robot mechanism and its immediate controls, such as off-line programming, CIM, vision and other intelligence forms."

Ken Goodwin, deputy chief, robotics division, National Bureau of Standards forsees an increase in mobile robots in the future. Mr. Goodwin sees such robots being used in the hazardous waste and mining industries; industries dealing with radiation, and nuclear waste disposal, and an increasing use of robots for painting and spraying applications. The technology creating mobile robots will filter down from the military, in which "battlefield robotics" is now an area of research and development, he said.

According to *Industrial Robots, a summary and forecast*, compiled by Tech Tran Consultants, Inc., future robot design will see specific changes in weight, strength speed, accuracy, flexibility, standardization, and lower cost.



Tactile, vision and other sensory technology has expanded the use of robots in industry. The operator here is programming a Unimate 900 small assembly robot with a vision system. The robot control is under the keyboard at left.

The report indicated that lighter materials such as plastics and composites will be used for robot structures and components; robots will become smaller but their relative payload capacity to weight will increase; robots will be faster due to direct drive motors and better control systems; and they will be more accurate, have flexible grippers and, most importantly, become less expensive as their electronic elements continue to decline, and production volumes increase.

The report also projected robots increasing in emerging applications such as maintenance and security, agriculture, forestry, mining, construction and a variety of service industries.

View from Europe

Technology Keeps Robot Industry Moving

By Peter Mullins
European Editor

According to Bjorn Weichbrodt, chief executive of ASEA Robotics in Sweden, the international market for industrial robots is expanding at 25 pct a year. The annual growth rate of his own company is 50 pct. ASEA has recently built a new robot manufacturing plant in Sweden and has started production in the U.S., France, Spain and even Japan.

The other major independent robot maker in Europe is the West German company, Kuka (Keller und Knappich Augsburg). Kuka is part of a large group which includes controls systems and welding equipment companies.

Volkswagen, Fiat and Renault all make their own robots, but have so far installed relatively few outside their own factories.

The greater bulk of the industrial robots installed to date are in the motor industry. The majority of these are used for spot welding. However, the spot welding market is showing signs of slowing down as carmakers' welding lines approach saturation and automatic assembly is providing a growing market. Robotic arc welding has been expanding over the last few years, but has not developed as fast as anticipated.

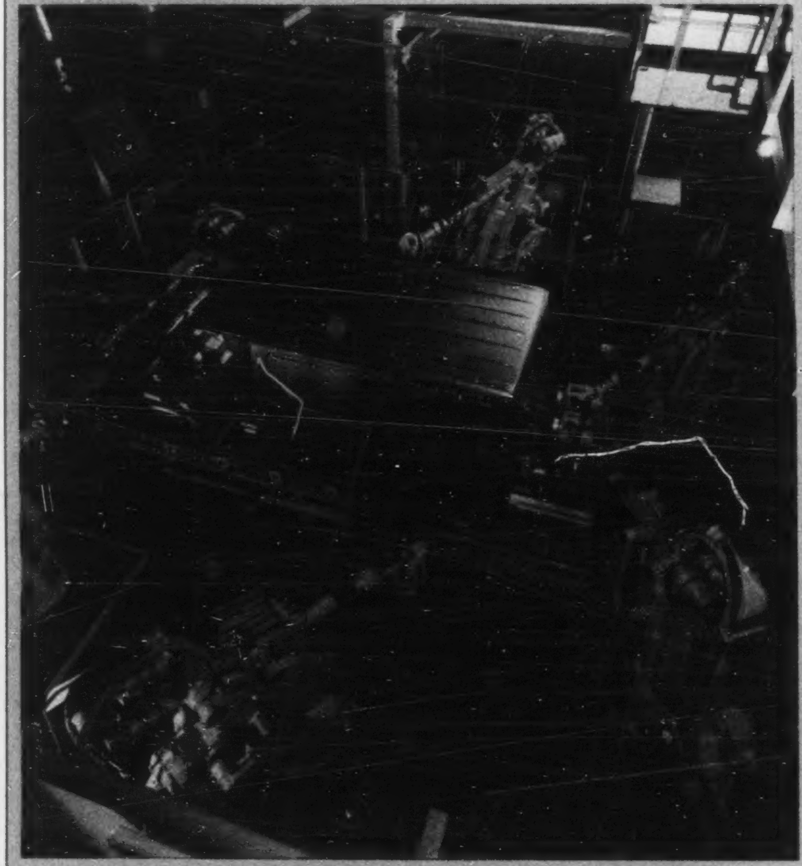
"There is still a big potential for robotic arc welding, but seam tracking devices and sophisticated sensors have not come along as fast as they should and are holding up development," noted Derek Wainwright, managing director of Kuka Welding Systems and Robot Ltd, Theale, England. "There is also a growing market outside the motor industry among makers of volume domestic proudcts like lawn mowers and garden tools."

The comparatively recent introduction of gantry-type robots indicates a trend towards denser robot installations, particularly on car-body lines. ASEA has pointed out that putting two conventional robots on either side of a line and hanging one over a work station saves space and also peripheral equipment.

An excellent example of this occurs on a brand-new production line in Holland where the small Volvo 480 ES is being made. (Incidentally, this car is being introduced in turbo form to the U.S. market in about year). On one work station, the floorpan of the car is welded on either side by two ASEA IRB90 robots while a Kuka IR 200/500 gantry robot carries out a weld in the middle of the component.

The 200/500 robot has been designed for very high pressing forces—up to a ton—mainly for single-sided welding operations where it is impossible for welding pincers to operate. In this case, the robot-held welding electrode is pressed against backing electrodes under the floorpan.

A very unusual approach to keep down the number of robots necessary in a given installation is the one adopted by the Italian robot specialist, Bisiach and Carru SpA of Turin. The Tauro



Kuka robots welding the body of a Transit van at Ford's Southampton plant. More than a hundred such robots are employed at the plant making literally scores of derivatives of the short and long wheelbase vans.

system as it is called (the acronym comes from the Italian equivalent of robotised universal automatic transfer) comprises two types of robots carriers: the first a gantry capable of taking one to three robots; and the other a smaller single carrier. Both are rail mounted and programmable.

These take the robots to the work, which may be a whole series of different models of car or truck...or tractors for that matter. A system of interchangeable welding guns gives great flexibility and avoids the necessity for having a separate robot for each weld gun. The system is similar to a machining center with tool magazine.

In a typical installation, the single carriers (each with a three-gun magazine) will move down the line working on either side of the workpiece. The gantry type (with an eight-gun magazine) will straddle the line.

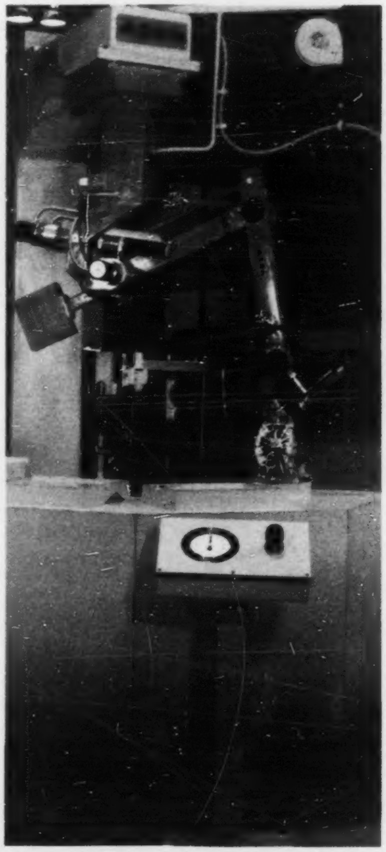
A recent example of the Tauro system at work is at Steyr-Daimler-Puch in Austria on a line making 6-wheeled cross-country vehicles. An interesting variation here is that the robot changes the weld gun for a manipulator at a certain point in the line and thus is able to carry out a certain amount of subassembly before welding.

In general, such an arrangement uses far fewer robots and is much more flexible than a conventional robot system.

Bisiach and Carru has pioneered a number of innovative ideas in robot welding. One is a double head, combining a weld gun with a manipulative pick-up; another is a double-tip gun with a programmable pitch.

It would appear that all robot specialist companies are trying to get more work out of their robot installations to amortise the high costs more quickly.

Robot installations are also becoming denser to save space. The gap between welding and automatic assembly is beginning to be bridged as robots combine the two functions.



ASEA Robotics' closed-loop adhesive /sealant dispensing system features a new electric gun and advanced system software that provide automatic compensation for gluing process variables.

to the robotics industry. "I have heard some people in the industry are becoming 'chilled' right now to automation...The U.S. manufacturer is like a spoiled kid, if it (machine) doesn't work right away, he doesn't want it anymore. People have to realize that it takes 50 years to turn around an industry base. You have to invest. But there are those in the business where their only obligation is to the dollar, and if it means going overseas to make a profit—they will."

Industry Trends

The robotics industry—like the rest of the machine tool industry—is currently in an environment that is not favorable to large capital equipment expenditures. However, this has not retarded industry analysts and forecasters from predicting that the robotics industry will continue to expand at a steady clip for the rest of the century.

It is inevitible that robots will become commonplace in both large and small plants in the future. After the current growing pains of factory automation subside, robots will tie into other plant systems offering vision sensing capabilities and off-line programming, that will increase quality and productivity and at a reasonable cost.

According to a recently published 235-page study by Tech Tran Consultants, Inc., Lake Geneva, Wis., entitled, *Industrial Robots, a Summary and Forescast* "new robots appearing on the market and emerging from research laboratories are considerably more 'intelligent' than their predecessors of two or three years ago.

The study outlined the following emerging trends:

- Robots equipped with vision sensing systems are just beginning to be used in manufacturing for part sorting, inspection, guidance and control. Although the use of tactile sensors in manufacturing applications is just developing, vision sensing is available now...and is expected to be available on about 50 pct of all robots by 1995. In addition, the report noted that standardized vision modules for general use with a variety of robots will be available; real-time processing capability will be standard; image resolution will be improved; three-dimensional vision sensing will be widely available; and range (distance) sensing capabilities will be widely available.
- Force or tactile sensors are becoming commercially available...It is expected that a high resolution complaint array type of tactile sensor with a high recognition capability will be available in the near future. Force and torque sensors will also be available, for monitoring and control of operations such as drilling, routing, deburring and assembly, the report said.
- New control techniques and hardware are the next most popular areas

of research. These efforts range from the development of advanced control algorithms which optimize robot performance to the use of advanced computing and memory devices. These include: Use of distributed processing techniques that decentralize computing and control requirements; development of hierarchical control techniques; increased intergration of sensory data into control procedures; greater use of adaptive control techniques in processing and assembly; advanced communications and networking techniques in robotic work cells and similar integrated systems; development of control techniques for collision avoidance, multiple armed robots, and mobile robots; increasing use of the latest electronic components, including 32-bit microprocessors and other VLSI devices; and application of artificial intelligence techniques and "expert systems" for robot control and decision making.

- The major trend in programming includes the development of a new high

Justifying That Purchase Order

By Sandra Brooks
Midwest Regional Editor

One of the greatest hindrances to implementing CIM technologies has been justification; robotics is no exception.

Sales of robots and robotic equipment have fallen far short of the predicted annual growth. Penetration of new markets is slow. More than half of robotic installations are being used for automotive applications.

Yet, those companies experienced with robotic use continue to cite an increasing list of benefits directly attributable to the equipment. A list which by itself substantiates repeat orders: improved process quality, reduced setup time, increased flexibility, reduced direct labor cost, reduced quality control cost, reduced inspection cost, reduced scrap/rework, warranty cost reduction and reduced equipment cost.

Undeniably, the first attempts to apply robotics to manufacturing were complicated by the limitations of robotic technology. But, in the past five years, significant improvements have been made in robotic reliability, functionality, ease of programming, control and communications interfaces.

Still, first-timers are slow to sign a $200,000 purchase order. In most cases, the issue lies beyond the capital investment—justification gets tied-up in 'what-if' scenarios.

As with any investment, analysis and planning are key factors. The installation of even one robot could significantly impact the entire manufacturing operation. Therefore, justification must go beyond dollar amounts and managers must assess the possible effects of process automation to the manufacturing cycle.

In preparing a proposal for the application of robotic technology to a process, the existing operation, both the specific process and the organization at large, must be totally analyzed and thoroughly understood to justify the purchase of robotic equipment.

The company's manufacturing philosophy, its cost/profit targets, the goals of marketing and sales, the logistics of material in and product out, and the quality of raw materials and finished goods are but a few of the global considerations which must be taken into account when planning for automation.

On the specific process level, factors such as operator modifications to process data/equipment operation, procedures, material and informtion flow, and inventory gluts or shortages will affect, and be effected by, robotic equipment.

Assess the factors which comprise your organization and identify where changes could result in cost reductions or improved productivity and analyze why. This exercise will become your list of opportunity for process improvement.

Then cite what is needed to implement changes to the process. Analyze the impact of additional training, organizational restructuring, new process scenarios and the impact of new equipment. Don't rule out benefits which might be gained by manual processing, hard automation, automation of installed systems, process capability and design improvement or process and design innovation. Rank the various combinations of possible solutions in terms of capital investment, installation complexity, support services required and projected benefits.

Develop realistic budgets with a built-in buffer for worst-case possibilities, not only in relation to the equipment purchase but for additional training, relocation of existing equipment, line shut-down, re-design/engineering of the product, etc.

Layout a conceptual design of the equipment installation and plan for implementation. If possible, computer simulate the effects of the process back through the organization. Evaluate through-put increases quality improvements, cost reductions, reduced lead-times, lowered inventory and improved process control.

Finally, project the payback period and the long-term return on investment—shoot for a maximum of two years payback and an ROI rate of 10 to 30 pct. Include an analysis on the effect of postponing the project in terms of project cost variance next year, two years and five years out. Also take into consideration the impact of postponing automation on competitive capability, both from perceived and actual product quality/cost perspectives.

Conclude the proposal with methods by which to assess the actual benefits compared with the projected benefits at various points in the implementation, gathering data from both preproduction and production operation.

risk level robotic programming language and off-line systems for work cell planning, robot programming and simulation. These later techniques, in particular, the report indicated, will become commonplace in the next decade because they greatly reduce the effort and cost required to program robots, help eliminate costly errors and lead to improved work cell performance.

- Although there is some interest among robot users for the development of a standard programming language, such a standard is not likely to emerge in the near future because of the diversity of application requirements, the number of competing approaches and the rapid pace in new programming developments. One or more languages, such as GMF Robotics' 'Karel', may emerge as industry leaders, the report noted.
- Regarding systems integration, the report said that it is recognized by both robot manufacturers and users that robots are a part of integrated manufacturing systems and that robots have only limited utility as stand-alone pieces of equipment. This recognition is leading to the development of a wide variety of turn key systems for specific applications such as welding, painting, sealant dispensing, material processing and assembly. This integrated systems approach is also one of the driving forces behind the development of new sensors, interfacing and programming techniques.

In the area of mobility, robot researchers, manufacturers and users are beginning to recognize the benefits to be gained in providing some type of mobility for manipulator arms. This has naturally led to an increase in the use of large gantry-type robots and additional axes of motion, such as tracks or rails for the robot to move along. Such mobility effectively increases the work envelope of the manipulator arm and allows the robot to interface with a wider variety of equipment.

State of the Industry

Eric Mittelstadt, president of the Robotic Industries Association and president and CEO of GMF Robotics, believes that the robotics industry is going through a "natural evolution" like any other industry. "Some analysts have been saying for a long time that robotics hasn't been doing what it was supposed to do. They (analysts) were discouraged when the industry grew 30 to 35 pct instead of the 50 pct they predicted. They were unrealistic. They didn't realize that we just now are coming out of one of the worst capital equipment recessions in the past 30 years. I look at the 30 pct growth as a positive sign in that kind of economy."

Added George Munson, president Unimation, Inc.: "The industry is crowded relative to the size of the market right now. In my opinion the key issue is where the individual stands in investing in factory automation, because proliferation is tied to that. The robot is not a stand-alone device that is disconnected from other technologies. So much depends on how the individual invests in factory automation.

The Best of the West

The top four robot manufacturers in the United States are GMF Robotics, Cincinnati Milacron, Unimation and ASEA Inc.

- **GMF Robotics:** Less than four years old, GMF Robotics is the largest full-service supplier of robots in the United States with 1985 sales around $187 million.

Formed through a joint venture between General Motors and Fanuc of Japan, GMF quickly rose to the top supplying robots to the automotive industry, the major end user of robotics.

GMF holds about a 30 pct share of the U.S. market. The company manufactures assembly, gantry, spray painting and material handling robots. In addition, GMF sells process robots for arc welding, waterjet cutting, sealing and deburring applications.

Although GMF is mostly noted for its sales to the automotive industry, the company has sold robotics to about 630 customers, of which less than 10 pct were automotive related. Of course most of GMF's volume sales are to the automotive industry, but the company is striving to increase its sales to non-automotive industries.

- **Cincinnati Milacron:** One of the early leaders in the industry, is second to GMF, with 1985 sales estimated to be more than $50 million.

A full-service company, Cincinnati Milacron offers gantry, articulated and cylindrical coordinate robots. The company, also a major supplier to the automotive industry, is branching out into other markets such as aerospace and batch processing.

- **Unimation:** Considered to be the pioneer in robotics, has a 9 pct share of the market, according to 1985 statistics, with sales estimated at close to $50 million.

The company, purchased by Westinghouse in 1983 from Condec Corp., offers assembly robots; robots for material handling, welding, drilling and sealing applications. Unimation also offers its VAL programming and control language.

- **ASEA-USA, Inc.,** A subsidiary of ASEA AB of Sweden, holds around 10 pct of the current U.S. market with 1985 sales estimated at around $40 million. However, worldwide, ASEA earned $120 million in sales and is one of the leading international robotics companies.

The company specializes in articulated arm robots that are used for welding, spraying applications, deburring and polishing. The company has sold approximately 5,000 robots worldwide.

ASEA also offers robotic support systems such as controllers, sensors, programming packages, and grippers.

Other robotic manufacturers worth noting include Adept Technology, DeVilbiss, American Cimflex, General Electric, U.S. Robots, ESAB, Prab and Panasonic.

Both Mr. Mittelstadt and Mr. Munson and other industry officials interviewed by PRODUCTION Magazine agree that there will be a "shake out in the number of robotics manufacturers within the next five to 10 years.

The industry is currently in a period of what some call "sustained growth." Close to 30 companies have already exited the market leaving about 70 manufacturers.

"There aren't as many robot companies as some people think," said Laura Conigliaro, a Prudential Bache Securities analyst and long-time observer of the industry. "It (number of manufactuers) will get smaller, not because companies will get pushed out, but because some companies won't be able to reach the masses to justify staying on.

Ms. Conigliaro asserted that the industry has some "real problems." She said that growth is very slow this year, about 5 pct over 1985 and the industry is a very "solutions-based" oriented industry right now. "Robots are hard to get installed and we're not in a good (economic) environment...it is affecting all capital equipment," she noted.

James Coshnitzke, manager of marketing and communications at Cincinnati Milacron, observed that he sees very few changes in the next three to four years in the industry. Mr. Coshnitzke said that the industry is moving towards off-line programming, vision and concentrating on penetrating other markets. "There will be a lot less R&D devoted to hardware," he said.

"The evolution will be in sensors and vision," said Brian Carlisle, president of Adept Technology, Inc. "Adept will concentrate producing generic products that have high performance capabilities. The evolution is in vision to simplify automated storage and retrieval, material handling and parts picking."

"I'm hesitant to say we should stop developing hardware," commented Mr. Mittelstadt. "It only takes one company to implement a new vision system or come up with a new manipulator that could put us all out of business. Technological advances have to be cost justified. We have to realize that the reason there are more robots in Japan than anywhere else is that they keep them simple. We don't understand that in the U.S. We tend to buy more technology than we need at times. Yes, we need complex robots for complex jobs and simple robots for simple jobs ...then the cost will be justified." Ⓟ

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15 TOP MANUFACTURING MANAGERS TALK ABOUT THE CHALLENGES OF THE FUTURE

SPEAK OUT!

"New technology is revolutionizing the world [illegible] computer-aided design [illegible] shop floor, it's clear that virtually every aspect of manufacturing is being impacted. And, to make matters even more challenging, technological development is accelerating." JAMES A.D. GEIER, Chairman & CEO, Cincinnati Milacron Inc.

FMS:
Where the Action is

Automated Parts Identification:
On the Verge of a Boom

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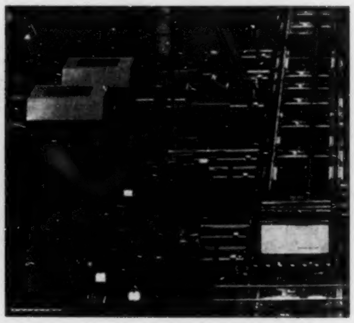

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World News UPDATE

MIDWEST

Machine Vision Eyes its Future

—Sales of machine vision products totalled \$58 million in 1985 and will reach \$457 million in 1990.

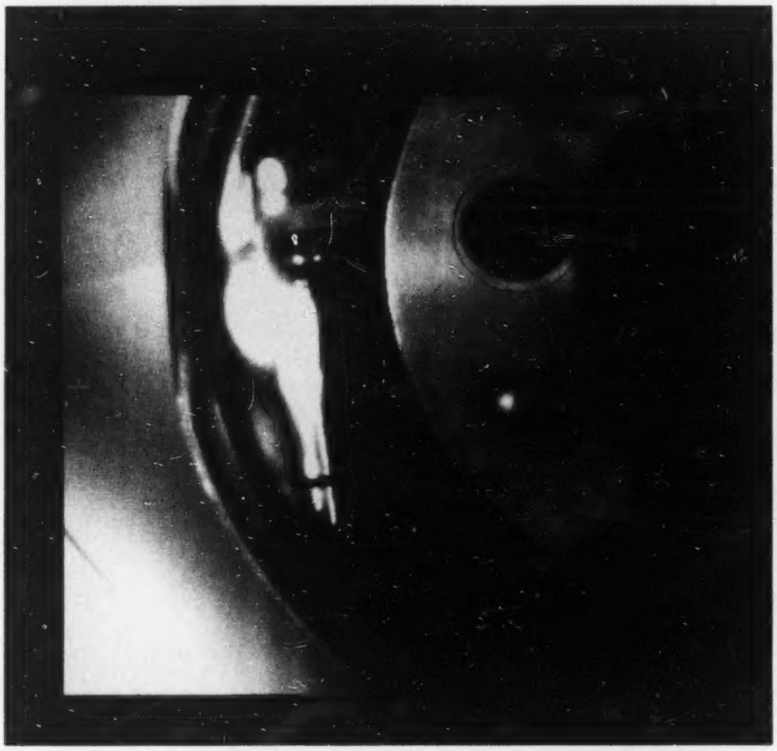
—Systems incorporating machine vision will grow from \$188 million in 1985 to more than \$2 billion in 1990.

—Gaging functions comprise the largest share of the vision market today, with inspection expected to comprise as large a share by 1990.

—Automakers make up the largest single market today, but electronics will surge ahead in 1990, with 36 pct of the market share.

—95 pct of the vision units in the U.S. are produced domestically. By 1990 this figure will be about 50 pct.

—Depending on application, the cost of a typical basic machine-vision unit ranges between \$25,000 and \$50,000. In 1990, the range will be \$15,000 to \$35,000.



An array of Diffracto Advanced Technology Z-Sensor cameras checks welded auto bodies at the Vision Show. Such systems are capable of 100 pct checking of the welded assemblies, detecting stamping accuracies and location of features such as holes to accuracies of .002 in.

All of these conclusions are based on an extensive Delphi study conducted by the University of Michigan for the Automated Vision Association. The findings were announced at the Vision '86 Conference & Exposition at Detroit's Cobo Hall, sponsored by the Society of Manufacturing Engineers and the Robotic Industries Association's vision affiliates.

Though the conclusions of the study are, for the most part, rosy, and industry growth seems assured, it is not all without trouble.

Outgoing association president James K. West, vice president, Perceptron Inc., said: "I feel that as leaders, we must own up to the fact that this promising industry is in a bit of trouble. The trouble stems from the fact that there are so few successful machine vision companies. This fact leads to increased skepticism on the part of Wall Street, which then encourages risk capital to seek more potentially fruitful fields for future investment."

As a result, many of the current vision companies are undercapitalized and survival will be a struggle for most of the small companies in the industry, according to industry analyses. Some guesstimates are that the current list, which could be as high as 200 is made up of only a dozen or so strong companies with successful applications to show. Of these, only about half a dozen companies made a profit on their vision business last year, or will in 1986. Drastic reductions in the number of companies in the industry seem inevitable.

"There will be fewer companies at the end of this year in this industry than there were in the beginning," said Michael Cronin, president, Automatix Inc.

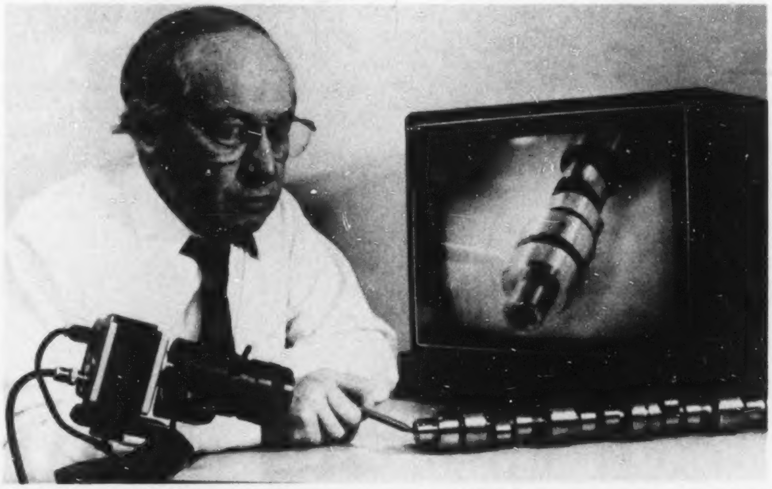
The University of Michigan Delphi study showed that most vision systems are for gaging, with inspection a close second, and that for the balance of the '80s, the patterns will change little. The findings:

Despite the fact that "process control" comes in at the bottom (See chart), some of those who indicated "inspection" may also be thinking of machine or process control. Gerald L. Elson, executive director, Artificial Intelligence, Advanced Engineering Staff, GM, said his company now has several hundred vision systems in a wide range of plants on a variety of application. "We can see the time when our total number of systems might be on the order of 40,000. Most will be used for machine or process control. By that I mean that we'll be inspecting parts and assemblies immediately after an operation, and then using the information real-time to make necessary process or machine corrections. We'll be inspecting, but we'll also be closing the loop."

Although the show did feature a number of new products, the emphasis seemed to be on applications, including the analysis of surfaces, gaging of dimensions to accuracies of—in some cases—tenths of a thousandth of an inch, checking part presence and orientation, and in several cases the guiding of robots. In fact, several spokesmen predicted that robots of the future will include vision as a standard sensor. It will be cheaper to use vision to track a part or to position the gripper than it will be to create the equivalent precision in robot rigidity and precision and to furnish software capable of doing the same job, according to one industry spokesman.

Perceptron's West comments: "The industry is still a child, but we have it in a very tough war where the performance demands create the most difficult challenges at every turn. What we now need are users who have a better understanding of the 'art' of vision, and who are willing to take the risk of applying it." The risk, in the right cases, might be minimal. The U of M study shows payback periods of less than 18 months as common.

"The industry today is somehwere in the second or third stage of a four-stage development curve." said Pierre Payne of Allen-Bradley. Mr. Payne, manager, commercial marketing, Sensing Products Business for A-B, explained that Phase 1 is the initial research and development phase in which hardware and software are proved possible and some experimentation on applications is tried. During Phase 2, the inventor/entrepeneur makes general prototypes and takes them to market ("an essential step because no one else knows how to do it"). Phase 3 is that stage at which the products, both hardware and software, are available as general-purpose products which can be tailored by systems integrators (third parties) for specific solutions. That, stressed Mr. Payne, is Allen-Bradley's current position.



Gould's new VS-1700 vision system is used to identify an automotive camshaft, which controls a multiple-programmed cam grinder.

Shipments of Machine Vision Systems, by Specific Application

	Percent of Unit Sales		
	1985	1987	1990
Verification	11	7	6
Counting	5	3	2
Character Recognition	7	6	6
Identification	7	6	5
Sorting	7	6	4
Gaging	27	27	24
Inspection	20	22	24
Flaw Detection	7	7	12
Adaptive Control	1	6	7
Seam Tracking	4	4	4
Process Control	4	6	6
Other	0	0	0
	100%	100%	100%

Finally, through substantial education and experience, Phase 4 is represented by users who are capable of taking standard, modular elements of a system and doing their own application engineering. "At this stage, the high cost of customizing and application engineering by suppliers will be reduced or eliminated and the prices will go down at the same time sophistication is going up, Mr Payne added.

Incoming president of AVA, Pat V. Costa, president and CEO at Robotic Vision systems Inc., acknowledged the need for education. "Our industry Delphi study shows that the single largest barrier to the implementation of machine vision is a lack of user expertise in developing applications."

Mack and Dana Sign 10-Year Agreement

Mack Trucks, Inc., Allentown, Pa., and Dana Corp., Toledo, Ohio, have signed a letter of intent providing for an extended-term business agreement.

Under the terms of the 10-year agreement, Dana will manufacture and supply Mack's requirements for complete front and rear axles, clutches and frame assemblies for use at Mack's assembly plants and in Mack's parts and service operations.

Dana has been a supplier to Mack for the past 80 years, providing over $100 million in parts to the heavy-duty diesel truck manufacturer yearly. Dana projects that as the agreement is phased in, that figure will double, based on today's prices.

As part of the agreement, completed frame assemblies with axles mounted, will be supplied to the Mack assembly facilities on a "line-set" basis to a Just-In-Time (JIT) schedule.

Dana currently operates a JIT assembly plant in Lancaster, Pa., supplying Mack's facilities in Allentown and Macungie, Pa. Mack axles are assembled there, using housings supplied by Dana and carrier sections, including drive gears and differentials, supplied by Mack. Under the new agreement, Dana also will produce the carrier section.

Mack's requirements for its new $80 million assembly facility currently under construction in Winnsboro, S.C., will be provided from a new Dana manufacturing plant also to be constructed in South Carolina near the Mack facility. Dana has not yet selected a site for the proposed 100,000 sq. ft. facility which is planned to employ 100. Both new plants are scheduled to be on-line by mid-1987.

Additionally, Mack and Dana will jointly further develop the electronic communications network which links the companies' financial and operating computer systems.

Metalworking Industry Capital Spending (Billions of Dollars)

	1985	1986F	1987F	Percent Change 1985–86	Percent Change 1986–87
Fabricated Metal Products	3.57	3.80	4.00	6.4	5.3
Nonelectrical Machinery	15.83	16.70	18.30	5.5	9.6
Electrical Machinery	15.57	15.90	17.60	2.1	10.7
Motor Vehicles and Parts	14.01	15.40	16.90	9.9	9.7
Aerospace	3.50	4.00	4.50	14.3	12.5
Instruments	3.80	4.10	4.40	7.9	7.3
Total	56.28	59.90	65.70	6.4	9.9

F = Forecast

Source: U.S. Department of Commerce, The Conference Board, Merrill Lynch Economics

Merrill Lynch is Bullish On Machine Tool Industry

Despite a sluggish first half, the balance of this year and all of 1987 show prospects for stronger economic growth as a result of moderating interest rates, substantially lower oil prices and some improvement on the import/export front. That's the conclusion of a "Machine Tool Outlook" report prepared by Merrill Lynch Economics Inc., New York.

The report concludes that capital spending in real terms will increase 4 pct this year and an additional 5 pct in 1987. "While lower oil prices are a net positive on the overall economy, they are causing substantial cutbacks in capital spending programs within the petroleum industry. A decline in investment by the petroleum industry of approximately 25 pct this year and 10 pct in 1987 is projected according to the report."

Other conclusions from the report:

—The Reagan defense built-up will continue to have a beneficial impact on the economy over the near term.

—Metalworking industries should experience a pickup in product demand over the near term with the single exception of the motor vehicle industry which will see production and sales decline modestly from their robust 1985 levels. Improved earnings in the metal working industries will stimulate action on existing capital projects and the initiation of new capital programs.

—Domestic producers of machine tools should see a pickup in orders and shipments reflecting an expanding U.S. market and some moderation in the flow of machine tools from overseas. The moderation of imports is based on the assumption that the drop in the value of the dollar and pressure from the administration will limit import penetration.

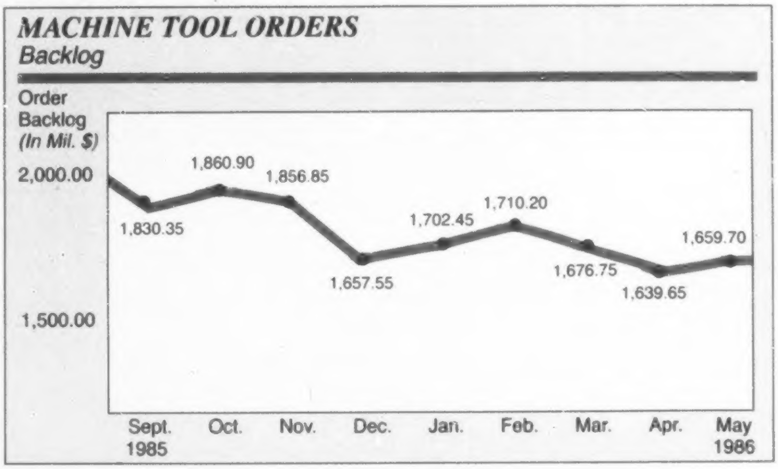
—Prospects for growth in overseas industrialized economies have improved, especially in the light of the decline in oil prices. This, in conjunction with a weaker dollar, will support U.S. efforts to export machine tools. Merrill Lynch now projects an increase in domestic machine tool orders of 22 pct this year and 23 pct in 1987. That projection is based on assumptions regarding increased activity by both the motor vehicle and aerospace industries than existed in 1985.

The Merrill Lynch report anticipates continuing advances in consumer spending; real consumer spending will reflect 3 pct gains in income both this year and next versus a 1½ pct gain in 1985 plus a perception on the part of the consumer that the individual financial net worth has improved.

In summary, Merrill Lynch anticipates that new plant and equipment expenditures by business in real terms will jump from 1985's approximately 377.5 billion to 393 billion this year.

WASHINGTON

Machine Tool Orders Surge In May


MACHINE TOOL ORDERS
Backlog

May orders for machine tools totaled $207.20 million, up 7.2 pct from April's figure of $193.25 million, according to the National Machine Tool Builders' Association (NMTBA). The biggest gain was in metal forming orders which rose 12.1 pct to $64 million from $57.10 million the previous month. Metal cutting orders rose from $136.15 million to $143.20 million, a 5.2 pct increase.

Despite the monthly rise, year-to-date orders for both metal cutting and metal forming machinery showed a decline from 1985. Metal cutting machine tool orders dropped from $821.35 million in 1985 to $742.85 million in 1986, a 9.6 pct decrease. Orders for metal forming equipment dropped from $313.10 million to $273.35 million for a loss of 12.7 pct. Total orders fell from $1,134.45 million to $1,016.20 million, a 10.4 pct drop.

"While it is good to see a rise in orders for May, it is important to maintain your perspective when considering these figures. The positive news that orders are up for the month is offset by the fact that orders through May are down 10.4 pct compared to a year ago," James A. Gray, president of the NMTBA, pointed out.

Total shipments of cutting and forming machinery rose by 8.4 pct for the month of May, up to $227.25 million from the $209.55 million posted in April. Almost all of the gain was in metal cutting shipments which rose to $169.70 million, an 11.6 pct gain over the previous month. Metal forming maintained a shipment level comparable to a month ago, rising from $57.45 to $57.55 for a 0.2 pct gain. Total cutting and forming shipments showed a 17.7 pct rise for the year compared to the same period in 1985.

Industry backlogs dropped from $1,659.70 million in April to $1,639.65 in May.

NTMA Projects 5 Pct Increase in Contracts

The outlook this year for the contract tooling and machining industry is expected to be up about 5 pct over last year, latest figures from the National Tooling and Machining Association indicate.

Previous forecasts had 1986 sales as merely equal to those of last year. However, the recent sharp declines in oil prices have convinced association forecasters to change their outlook, the NTMA said.

Although the forecasters do not see oil price declines (along with other recent economic improvements) creating substantial expansion in NTMA markets, the combined beneficial impact greatly reduces the chances for a recession beginning later this year.

The second and third quarters have the potential for producing stronger NTMA business prospects than this year's first quarter did, the association projected. Although frew NTMA companies are likely to experience great sales expansions this year, according to the NTMA, fewer than had been predicted will experience marked downturns in business later this year.

The 5 pct projected increase in overall sales (shipments) will affect individual association sectors as follows: Molds are now projected to grow by 5 pct; tools, dies & fixtures, up 8 pct; and aerospace machining and fabrication is predicted to increase 12 pct over 1985. General precision machining and special machines are both expected to drop 5 pct however.

Prospects for major NTMA customer markets remain strong this year, the poll showed. New orders in dollar volume are expected to be higher in each of the major customer market sectors. Electronic components sales are now expected to rise 15 pct this year rather than the previously predicted 12 pct.

New order forecasts for motor vehicles and parts, aircraft, space vehicles and missiles and construction, mining and oil field equipment remain unchanged from previous forecasts and are still expected to be up by 3 pct, 10 pct and 5 pct, respectively.

Household appliance orders are still projected to increase by 6 pct this year, however, this could be revised upward by the next quarter if the current economic upswing continues, the association said.

–Washington, D.C. reported by Ed Bowers/Maryland

Automated Parts Identification: On the Verge of a Boom

While bar coding is the most popular, an assortment of other technologies are competing for a larger share of the market.

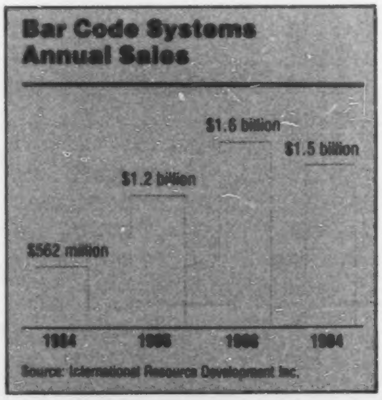
By Al M. Senia
West Coast Editor

WITH MANUFACTURERS DESPERATELY seeking cost improvements and production enhancements, the domestic automated parts identification systems industry appears to be heading for a boom.

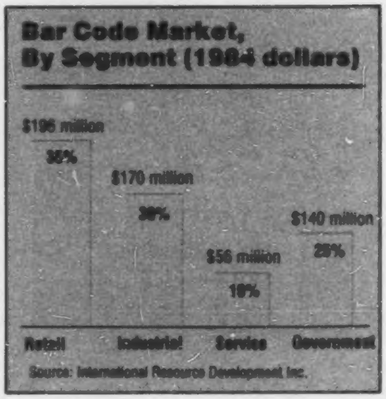
The technology to automatically track parts and inventory actually has existed for more than 25 years. It first appeared when Sylvania developed an automated symbol to aid in identification of railroad cars in 1960.

Since then, the technology gained growing appeal in a number of select markets: supermarkets (in the 1970s), libraries, the health professions and other service industries. The ubiquitous bar code symbol now has become familiar to American consumers.

If corporate officials and analysts are to be believed, manufacturers are poised to discover the benefits of automatic identification systems in a large way. The technology is being touted as a major means of accurately tracking virtually any part through production, warehousing or distribution. Lower direct labor costs, more accurate audits and higher factory productivity all are touted as major benefits of the automatic identification technologies.


Bar Code Systems Annual Sales

Source: International Resource Development Inc.


Bar Code Market, By Segment (1984 dollars)

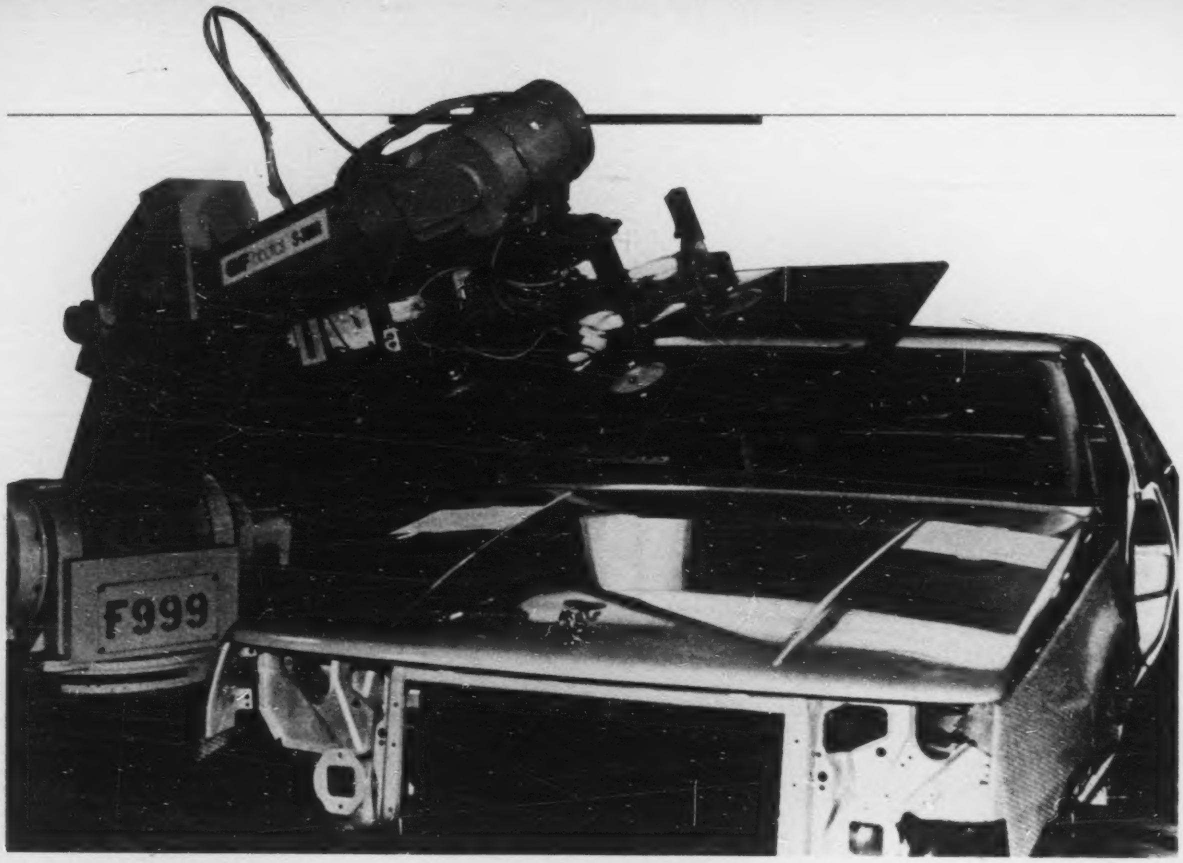
Source: International Resource Development Inc.

The first major issue facing the industry is determining which of the competing technologies will win out. Several various types of automated technologies currently are competing in the marketplace. Bar code systems are by far the most popular, claiming over 90 pct of the market, especially in the industrial setting where their use is expected to climb dramatically by the end of the decade.

But an assortment of other technologies is competing for a larger share of the market now dominated by bar codes. These include Optical Character Recognition, or OCR; machine vision; image processing and transmission for personal computers; microwave and radio frequency (RF) systems; keyboard data entry; magnetic strips; and voice technology.

"The most serious competition to the bar code industry comes from optical character recognition technology," concluded a recent report issued by International Resource Development Inc., a Norwalk, Conn, research firm that has analyzed both the bar code and OCR markets.

"There are several advantages to OCR in certain applications. It is directly legible to a human worker; it can



GM's Buick City plant is expected to use bar coding technology within its operation.

be printed more easily than bar code; it allows denser encryption; and so forth."

But the report also noted that present-day OCR systems are not as reliable as their bar code counterparts. Also, they operate less rapidly. More significantly, OCR often is more expensive.

"OCR competes with bar coding most effectively in certain POS and materials handling applications," concluded the IRD report. "There are many other applications, however, where the two technologies can be effectively used in concert."

Most industry analysts believe bar coding will win out, especially in the industrial environment.

"Bar code devices usually cost only a couple of hundred dollars, while devices like scanners and OCR readers are a lot more expensive," said Hedy Taub, an analyst with Future Computing Inc., a Dallas-Texas based market research firm.

One element fueling the market is the availability of new hardware and software programs for personal computers. This is helping to drive down the cost of installing parts identification systems for smaller manufacturers.

For example Computer Identics of Canton, Mass. recently introduced a product called Mac-Barcode for Apple's MacIntosh computer. Priced at $395, the software package can produce bar codes. However, it must be used in conjunction with a $600 Scanstar-Mac barcode reader which connects directly to the computer via the keyboard.

Industry officials believe the product will find a specialized niche, especially among small manufacturing companies attempting to comply with bar code specifications from the Defense Department.

Future Computing projects sales of all such personal-computer based equipment to soar to $40 million in 1986, up from $28 million in 1984. Specific figures for the industrial environment were unavailable.

Growing Industrial Use

International Resource Development projects, the most explosive growth in the bar code trade, will involve the industrial marketplace despite the fact that sales to this segment were relatively small before 1983.

"The most radical growth in the entire bar code industry will occur in industrial settings," said a recent IRC report. "Increased productivity will be needed if American industry is to remain competitive."

Company analysts believe that an increasing percentage of industrial capital and research-and-development funds will be plowed into productivity improvements like bar coding.

"It is universally predicted that CAD-CAM, flexible manufacturing, just-in-time delivery of components, LANs (local area networks for computers) integrated MRP, robotics and similar approached to saving time, money and labor will be pursued vigorously during the coming years," said the IRD report.

Company analysts predicted that the greatest potential for industrial bar coding is in allowing computers to identify batches of items during the manufacturing process. Then the computers can be programmed to instruct workers at stations throughout the production line

Auto Manufacturers Plans For Bar Coding Delayed

The automobile manufacturing industry has been among the strongest proponents of bar code technology, but the results so far have been mixed.

Deadlines for suppliers to meet bar coding standards have been rolled back several times because of equipment shortages and other delays. Chrysler, for example, originally set an Aug. 1, 1985 deadline for bar code compliance. But this was shelved after suppliers complained equipment shortages made it impossible to meet the goal.

More recently, General Motors set a June 30, 1986 deadline for its suppliers. Company officials said the date will stand, although they conceded it was likely many suppliers won't comply with it.

However, there are signs that the industry is beginning to toughen its view that bar coding is necessary for the industry's estimated 20,000 suppliers. G.M. plans to monitor compliance this summer and to send those who fail audits complaint notices.

"You receive enough complaint notices and it's no more business," one company official explained.

Don Heydens, a G.M. bar code expert and member of the Auto Industry Action Group (AIAG) said, "There has been some relaxing of the (June 30) start-up date. The real problem has been getting enough of the right kinds of equipment delivered on time."

G.M. has been sticking to its officially proclaimed date, although some suppliers won't be complying. "If you change the target, you never reach the goal," Mr. Heydens explained.

He estimated some 5,000 suppliers are involved in the effort. Some officials have estimated as many as 20 pct of the suppliers won't be in compliance at the deadline date.

G.M. currently is surveying its suppliers to measure compliance. Results should be available in September.

"Some of the very good suppliers are anxious to get going," said Mr. Heydens. "We're not progressing as fast as we should be. Not all suppliers are as willing as some of the others. The guy who supplies just one or two parts is somewhat reluctant."

While equipment shortages are a valid concern, some companies suppliers simply don't want to make the necessary capital investment. Under the G.M. guidelines a supplier can either purchase the equipment himself or purchase the bar code labels from an outside vendor.

Ford also is seeing resistance from its suppliers, which are estimated at more than 2,000. The automaker hasn't established a firm compliance date, but is urging its supply companies to go along.

Officials for both companies believe parts suppliers need to be convinced that the emerging bar code standard isn't just to benefit the large manufacturers.

"Bar coding wasn't meant to be a one-way street," said Mr. Heydens. "The beauty of the AIAG standards is that they can provide a benefit to both ends. We can use it on the receiving end to cut costs and they can use it on the shipping end for better efficiency."

Meanwhile, the manufacturers are proceeding with their own internal bar code systems. Some Ford engine and transmission division have utilized bar code technology for process and product control identification for four or five years. More recently, a casting and a glass plant have switched to the equipment.

G.M. is making greatest use of bar codes in its Buick City operation, although the massive Saturn Project, scheduled to go on line in 1989, will likely make extensive use of the technology.

All material that passes through 21 receiving docks at the plant is barcoded, and then automatically received, sorted and disbursed.

Previously the task was done by hand. Said Mr. Heydens: "The entire task used to be manual, with workers using note pads and clipboards."

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what to do with items identified by bar code scanners at the locations.

"Acceptance of bar code technology by smaller factories will depend to a large extent on the availability of inexpensive, sufficiently accurate, reliable bar code printers and scanners," said the report.

But bar code equipment manufacturers already are getting the message about the industrial environment.

David J. Czaplicki, director of corporate communications for Intermec Corp., a bar code manufacturer based in Lynnwood, Wash. outside of Seattle, said the company has broadened its product lines to fit different industrial settings.

For example, one new hand-held scanner adapts to the assembly line and can read bar codes from longer distances in the factory.

Before 1983, most of Intermec's sales were to the grocery, health care and other non-industrial settings. Now some 80 pct of sales are industrial based.

"A lot more of our business is industrially oriented," said Mr. Czaplicki. The company switched its emphasis to this market in 1983. Intermec's overall sales grew from $26.9 million in 1984 to $43 million in the corporation's 1986 fiscal year which ended March 31.

He views the electronic manufacturing as "the largest segment of business we see."

"It's a high technology industry and it gravitates quicker to high technology solutions," explained Mr. Czaplicki. "The people in the electronics industry are not so afraid of the hard costs."

The Push to Standards

Two other industries that have propelled bar code systems growth are the auto industry and the defense industry. In both cases, key customers—General Motors Corp. for cars and the Department of Defense for weaponry—pushed adoption of the technology, as well as the emergence of standards.

In GM's case, as early as 1976 the industrial giant began requiring the use of bar codes on emission control components built for cars and trucks. It since has broadened the use of bar codes to other major suppliers.

In fact, GM, Chrysler, Ford, American Motors and Volkswagen of America have joined together to release standards for the bar coding industry and its large supplier base, estimated at more than 28,000.

The Big Three U.S. carmakers joined forces through the 300-member Automotive Industry Action Group (or AIAG) to prod the industry-wide adoption of bar code technology.

But in some cases, there have been problems.

Chrysler Corp. was the most aggressive and the first automaker to announce, in January 1985, that all of its suppliers would provide bar coded parts by August.

But the deadline had to be rolled back for several months because increasing demand for bar code hardware resulted in shortages. An estimated 40 pct of Chrysler suppliers couldn't comply with the order because they couldn't acquire the technology, according to Chrysler officials.

Use of bar codes in auto manufacturing still is trailing behind earlier predictions.

"We're seeing the purchase of bar coding equipment going along more slowly than we originally thought," said Intermec's Mr. Czaplicki. "We thought it would pick up a lot faster than it did, but it is just not meeting the expectations we originally saw.

"There has been a lot of momentum in the auto industry. But it hasn't been carried through to the end suppliers."

Actually the defense industry was the first to mandate industry-wide adoption of bar code technology. The Department of Defense in 1982 began requiring suppliers to put bar codes on all parts and supplies shipped to military installations.

Adoption of the so-called Logistics Applications of Automated Marking and Reading Systems (or LOGMARS) program was a major boom to the bar code industry. Originally, the DoD recommended the use of alpha-numeric legends under the bar code symbols, which eliminated the need for machine-readable technology.

But this requirement ultimately was dropped after competitive reliability tests showed that out of 1.2 million bar-coded labels, there were only four errors.

Eventually the LOGMARS bar code requirement is expected to impact more than 50,000 American manufacturers.

Competition Changing

Much like the computer industry evolved, industry officials like Intermec's Mr. Czaplicki see the bar code market changing into one where end users demand a systems oriented approach to solving their production or manufacturing problems.

No matter who wins the impending battle to supply the industrial market, one thing seems certain. Business is booming.

This trend is causing larger manufacturers to enter the bar code field with the aim of muscling out smaller, independent bar code manufacturers.

Hewlett-Packard, Burroughs, Data General, NCR, General Electric and IBM are prominently mentioned as large companies with expertise in high technology that are anticipated to emerge as key players in the bar coding industry.

Hewlett-Packard already is addressing the manufacturing. Six different divisions of the company are manufacturing bar coding equipment and devices. Among the recent introductions is a hand-held industrial computer for use in remote manufacturing data collection.

Claudia Devoux, a company spokesman, said HP's bar code equipment sales have grown from $40 million in 1984 to $47.5 million in 1985. Customers run the gamut from professional service providers like doctors to aerospace parts manufacturers.

"The Defense Department standards in 1982 signaled the first big move into bar coding," Ms. Devoux explained. "Now all kinds of different industries are jumping on the bandwagon—transportation, distribution, retail.

"We see the biggest growth taking place in manufacturing, to keep track of parts in the factory. The technology is critical to just-in-time manufacturing."

Independent companies like Intermec are responding to the pressure from larger operators by opening up new distribution channels and taking a more hands-on approach.

"The market is getting so widespread that people utilizing it are no longer the micronoids of yesterday," said Mr. Czaplicki. "They want a business solution to their problem. They look at the total cost, versus the return on their investment.

Intermec is purchasing its own distribution network for its products, and trying to make them more intelligent and less expensive.

No matter who wins the impending battle to supply the industrial market, one thing seems certain: Business is booming.

International Resource Development estimated the size of the industrial bar code market to grow from 40 to 60 pct annually from 1984 sales of $170 million. By the end of the decade, sales should exceed $1 billion annually.

Nearly 150,000 factories in the U.S. are candidates for bar code equipment. Most will utilize it for simple inventory and labeling, with smaller numbers acquiring it for heavier automation tasks.

"The bar code industry is a healthy one," IRD concluded. "At present it is not seriously threatened by the advocates of other technologies."

While the Defense Department, grocery industry and health services all have boosted use of bar codes recently, industry proponents believe the technology will ultimately triumph in more traditional settings for two simple reasons: It saves money. And it increases productivity.

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SEPTEMBER 1986

PRODUCTION

FOR MANAGERS OF MANUFACTURING TECHNOLOGY

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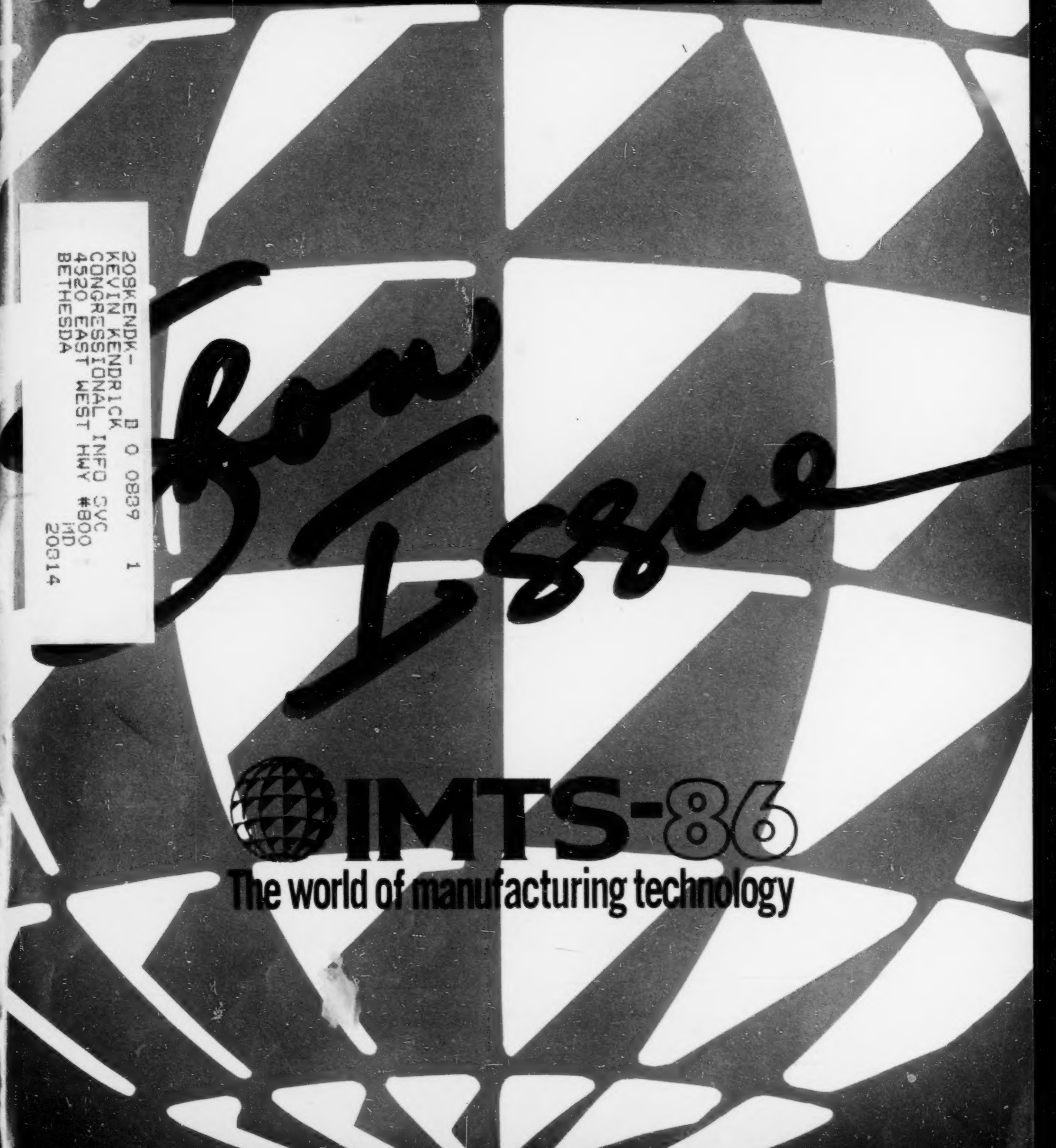

IMTS-86

The world of manufacturing technology

PRODUCTION

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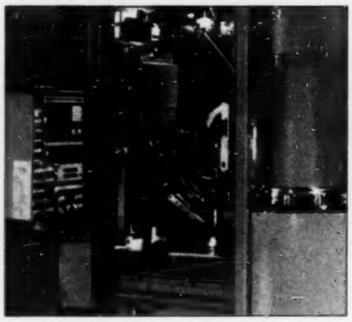

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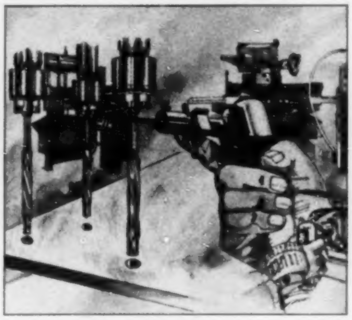

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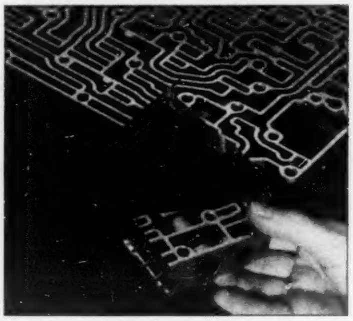

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WASHINGTON

Government Programs Offer Industry Help

A variety of government sponsored programs have been established through the years with the sole purpose of improving U.S. manufacturing capabilities. One such program, NASA's Technology Utilization Program, mandated under the Space Act, has successfully transferred its technology to the commercial sector for non-aerospace applications for more than 20 years.

For example, U.S. automakers have repeatedly drawn upon NASA resources to apply its advanced materials technologies to the development of ceramic and composite materials applications for automobiles. A heavy equipment manufacturer is drawing upon NASA's ultrasonic techniques to measure the properties of casting materials for non-destructive testing. In yet another instance, advanced turbo charged engines are being developed with the use of NASA software to calculate mass flows and predict performance.

The Technology Utilization Program is divided into two service areas—information and applications engineering. Information is available through a bi-monthly technical journal, NASA licensing agreements can be negotiated. However, more than 90 pct of the NASA developed technology lies within the public domain.

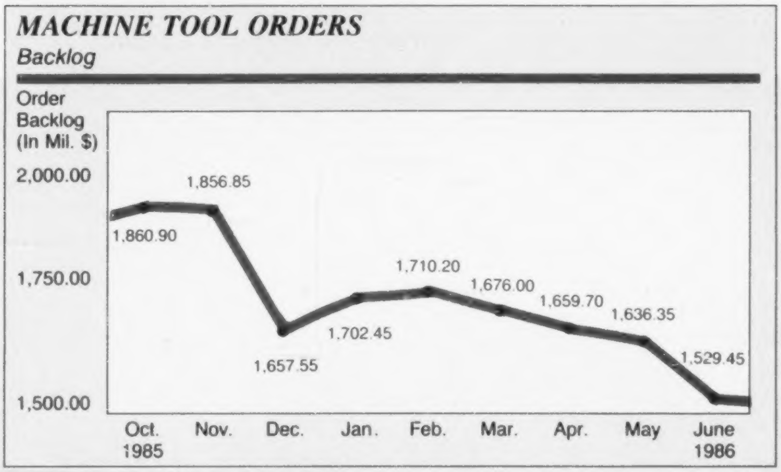
In addition, NASA field centers are available, by agreement, for R&D use. Under a Technical Exchange Agreement, NASA and a company will share information, facilities and expertise and jointly conduct research, testing and evaluation. In other cases, NASA TECH BRIEFS, available free to qualified individuals and organizations, the annual report, SPINOFFS, and a network of Industrial Applications Centers (IAC).

The IACs maintain computerized information banks of technical data and also offer technical consultation services and/or referral to other experts. User fees are charged for IAC information services, typically $100 to $300 for a database search and $2,000 to $3,000 for technical consultations.

A Technology Application Team is available for technology matching and problem solving assistance to identify and solve critical problems with existing NASA technology. Occasionally, NASA will hold a patent—in that event and the company will cooperate.

Finally, NASA and other government agencies have made available software programs and related documentation.

–Washington D.C. reported by Ed Bowers/Maryland


MACHINE TOOL ORDERS
Backlog

Machine Tool Orders Sag in June

Machine tool orders fell 11.2 pct for the first six months of 1986 compared to the same period a year ago, according to the National Machine Tool Builders' Association (NMTBA).

Mid-year orders totaled $1.2 billion. This reflects a 10.6 pct year-to-date drop in orders for metal cutting equipment and a 12.9 pct drop for metal forming.

For the month of June, metal cutting orders rose 10.7 pct over the previous month to a total value of $156 million but were down 14.2 pct compared to June a year ago.

Metal forming orders fell 31.2 pct for the month to a total of $44 million resulting in a combined cutting and forming drop in orders of 2.4 pct.

Total shipments of cutting and forming machinery rose by 34.2 pct for June, to $308 million from the $229 million for May. Shipments of metal cutting equipment rose to $241 million, a 40.2 pct increase while metal forming shipments rose to $66 million, up 16.2 pct. Year-to-date shipments were up 20.3 pct over 1985.

The spurt in activity in shipments caused industry backlogs to fall to $1,529.45 million in June.

Metal cutting backlogs were down to 1,188.25 million and metal forming backlogs fell to $341.20 million.

"The decline in orders for the first half of 1986 is very troubling to us but it is not surprisingly given the tentative attitude of investors of capital equipment as they wait out the tax debate," said NMTBA President, James A. Gray.

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OCTOBER 1986

PRODUCTION

FOR MANAGERS OF MANUFACTURING TECHNOL

Integrating Material Handling into the Automation Process

Control Starts In the Tool Crib

Europe's Best Flex Systems

Highlights of IMTS '86

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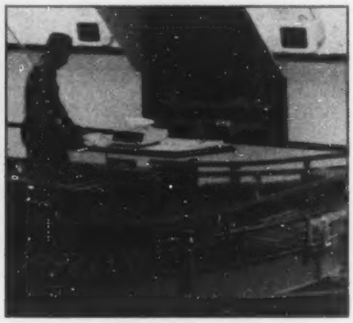
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INTEGRATING MATERIAL HANDLING INTO THE AUTOMATION PROCESS

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CONTROLS START IN THE TOOL CRIB

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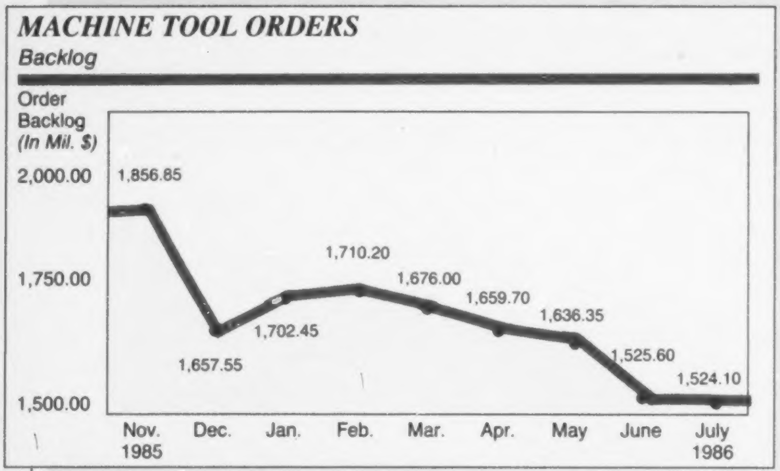
MACHINE TOOL ORDERS
Backlog

Machine Tool Orders Fall in July

The National Machine Tool Builders' Association (NMTBA) reported that July orders for machine tools totaled $189.15 million, down 6 pct from the $201.15 million June figure. Cumulative orders for the first seven months of 1986 were $1,405.50 million, down 10.4 pct from the same period a year ago.

July orders for metal cutting machine tools fell 4.5 from June, posting a total of $149.75 million. This figure is almost identical to July a year ago, when the total was $149.85 million. Year-to-date orders for metal cutting machine tools were dwon 9.2 pct compared to the same period in 1985. Metal forming equipment orders, totaling $39.40 million for July, were down 11.2 pct from June and down 21.2 pct when compared to July a year ago. This represents a year-to-date drop of 13.9 pct.

"Summer is traditionally a slow period for the machine tool industry. In addition, buyers frequently defer purchase decisions in the months immediately preceding our International Machine Tool Show. Therefore, we remain confident that the situation will improve as we move into fall and industrial activity picks up," commented James A. Gray, president of the Association.

Shipments of metal cutting machine tools fell to $151.60 million from $244.80 million in June, a drop of 38.1 pct. July's figure represents a 21.2 pct rise compared to July a year ago and 27.8 pct rise for the first seven months of 1986 compared to the first seven months of 1985. Metal forming machine tool shipments fell to $39.05 million for July, a 41.8 pct drop from the June figure of $67.10 million. This represents a 44.0 pct drop in metal forming shipments from July a year ago but only a 3.2 pct drop in total year-to-date shipments.

Combined shipment figures for metal cutting and metal forming machine tools fell 38.9 pct for the month but rose 17.2 pct for the first seven months of 1986.

DOE Finances 'Clean Coal' Research

Nine "clean coal technology" projects have been named as the Department of Energy's top choices to demonstrate a new generation of environmentally clean coal concepts.

The projects, picked from 51 proposals submitted to the agency in April, were chosen on the grounds that they offered the greatest likelihood of successfully demonstrating and subsequently commercializing emerging clean coal technologies.

The first facilities to use technologies under this program could be built and in operation within several months after cooperative agreements with the government are signed, although some of the larger projects will not be ready for testing until the early 1990's.

The nine companies named are as follows: Weirton Steel Corp., Weirton, W. Va.; American Electric Power Service Corp., Columbus, Ohio; the M. W. Kellogg Co., Cairnbrook, Pa.; Babcock & Wilcox, Allaince, Ohio; Ohio Ontario Clean Fuels Inc., Warren, Ohio; Coal Tech Corp., Marion, Pa.; General Electric Co., Cincinnati; Energy and Environmental Research Corp., Irvine, Calif.; Energy International Inc., Cheswick, Pa.

If agreements are reached with all of those selected, the proposers will share $360 million in federal funds while contributing nearly $600 million in total private financing. The 65-35 ratio of private to federal funding is well above the minimum 50-50 cost-sharing required by the Congress when it established the program in 1985.

When the Congress appropriated almost $400 million for the program last year, it mandated a full competition open to all markets. The nine projects selected propose new coal technologies for a variety of different market applications, including utility power generation, industrial processing, steelmaking and fuel production.